MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A
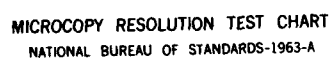
Technical Report NAVTRAEQUIPCEN 81-M-1083-1

DEVICE 2F119 (EA-6B) WST)
INSTRUCTOR CONSOLE REVIEW

Dr. John P. Charles
ICON, Inc.
San Diego, CA 92106

November 1982

FINAL REPORT DECEMBER 1981 - MARCH 1982

DTIC
ELECTE
DEC 20 1982
S   D
B

NAVAL TRAINING EQUIPMENT CENTER
ORLANDO, FLORIDA 32813

82 12 90 015

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER NAVTRAEQUIPCEN 81-M-1083-1	2. GOVT ACCESSION NO. A122639	3. RECIPIENT'S CATALOG NUMBER –

4. TITLE *(and Subtitle)* Device 2F119 (EA-6B WST) INSTRUCTOR CONSOLE REVIEW	5. TYPE OF REPORT & PERIOD COVERED Final Report
	6. PERFORMING ORG. REPORT NUMBER –

7. AUTHOR(s) Dr. John P. Charles	8. CONTRACT OR GRANT NUMBER(s) N61339-81-M-1083

9. PERFORMING ORGANIZATION NAME AND ADDRESS ICON, INC. 3401 Bangor Pl. San Diego, CA 92106	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS NAVTRAEQUIPCEN Task No. 1783-1P1

11. CONTROLLING OFFICE NAME AND ADDRESS Naval Training Equipment Center Orlando, FL 32813	12. REPORT DATE November 1982
	13. NUMBER OF PAGES 87

14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)*	15. SECURITY CLASS. *(of this report)* Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Simulator Training	Design Guidelines
Instructor Console	Device 2F119
Simulator Instructor	

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

A survey of training Device 2F119 instructor console operating problems was conducted. Feasible solutions were developed. Recommendations and conclusions were developed. General design guide information was prepared.

DD FORM _{1 JAN 73} **1473**   EDITION OF 1 NOV 65 IS OBSOLETE
 S/N 0102-014-6601 |

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

SUMMARY

Reports of operating problems with some of the newer airborne weapons systems trainers led the Naval Training Equipment Center (NAVTRAEQUIPCEN) to conduct a review of the instructor console and operational utilization of Device 2F119, the EA-6B Weapon System Trainer. The review included a survey of current training operations, interviews with instructors and training managers, analysis of the console design, and a review of related documentation. The goal was to identify any console design deficiencies and develop feasible solutions. In addition, identification of any "design guides" to preclude similar problems in the future was undertaken.

Visits to Naval Air Station Whidbey Island were made. Problems and operations were discussed with personnel at the Medium Attack Tactical Electronic Warfare Wing Pacific (MATVAQWINGPAC), the Fleet Readiness Squadron (VAQ) 129, the NAVTRAEQUIPCEN Field Engineering Office and at the Fleet Aviation Specialized Operational Training Group Pacific Fleet Detachment NAS Whidbey Island. A sampling of training events involving both the Fleet Readiness Squadron and Fleet Squadrons were observed and discussed with instructors and operator personnel. Related documentation was reviewed including syllabus guides, scenarios and trainer documentation.

A wide variety of console problems was found, ranging from basic human engineering defects to utilization and related instructor manning and training problems. While many of the design deficiencies were minor in nature, the overall result is such as to seriously impact the device's training effectiveness and costs.

Among the conclusions reached were that while the Device is a very sophisticated simulator:

1) Fleet squadron personnel will be unable to operate it except for basic procedures training and similar events unless instructor-operator support is provided.

2) The trainer lacks many basic training functions which severely limit its effectiveness and usefulness.

3) Many display and control changes are required to achieve the required operability.

4) Changes to trainer procurement and specifications are required to preclude recurrence of similar problems.

The recommendations which followed include:

1) Professional instructor-operators should be hired to support mission training and training event programming.

2) The trainer operating software should be modified to permit simultaneous training operations including mission training, debriefing-replay and hard copy output. In addition, simultaneous use of the flight mode and the tactics mode should be available.

3) Addition of part task-trainers, especially for cockpit procedures and Radar/Navigation, should be implemented to provide more device time for mission training which can be expected to increase.

4) Performance and mission effectiveness models should be added to the trainer to aid in individual and crew performance and readiness evaluation. Such models and techniques are state-of-the-art.

5) Display and control deficiencies must be corrected. However, because of the interactive nature of the problems, the feasible solutions, the instructor-operator capabilities, the training scenario and the training objectives, a change requirements analysis and tradeoff should be conducted to ensure that enhancements are made rather than problems compounded.

2

PREFACE

In general, a survey to identify problems and deficiences
(if initiated by valid inputs) will find some and in the process,
raise the issue of why and how they occurred. The opportunities
are manifold in the case of a complex piece of equipment such as
a weapons system trainer for a four man Electronic Warfare (EW)
system. Even greater possibilities can arise with changes in
technology, personnel, performance requirements and operations
which occur after the military characteristic is drafted. In
short, while some of the basic human engineering deficiencies
which were found in this study should probably not have occurred,
most of the problems result from these factors and do not reflect
on the personnel who contributed to this survey.

While a great many officers and men contributed and helped
in coordinating the data collection and analyses, the efforts
of the following personnel should be recognized:

Mr. James Bolwerk, Commander Naval Air Force U. S. Pacific
Fleet staff who sponsored and guided the survey at NAS Whidbey
Island.

Captain Grady Jackson USN, Commanding Officer VAQ-129
whose insight and interest in the problem greatly facilitated
the effort.

LCDR Mike Hewitt USN, VAQ-129 2F119 officer and Fleet Project
Team member.

LCDR Stan Spencer USN, VAQ-129 2F119 officer and Fleet
Project team member.

LCDR Carl Beaudett USN, VAQ-129 EW Department Head

Mr. Willie Christmas, NAVTRAEQUIPCEN Field Office 2F119
Engineer and Fleet Project team member.

The support of the staff at the FASOTRAGRUPAC Detachment
was essential to the survey and the data and inputs of the tech-
nicians and operator personnel was invaluable.

Overall, the interest and support of all the personnel in-
volved with Device 2F119 was outstanding and their interest in
assisting in identifying problems and structuring feasible
solutions was instrumental in the completion of the report.

FOREWORD

This report is the first of a series where the Human Factors Laboratory of the Naval Training Equipment Center is examining the human engineering of current state-of-the-art training devices. This series of studies will first examine flight training systems and then will turn to surface and subsurface training devices with the goal of developing a data base of the results of current training device procurement practices. Devices were selected which represent applications of current technology yet which had been in place long enough for the accumulation of operational usage that can reflect the appropriateness of the many design decisions which had to be made during their development. The goal of this effort is to develop guidelines and specifications to support the procurement of training equipment.

G. L. RICARD
Scientific Officer

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

SECTION I

INTRODUCTION

BACKGROUND

In 1974, the NAVTRAEQUIPCEN conducted a study of the role of the Instructor Pilot/Naval Flight Officer (IP/INFO) and the Simulator Operator (SO) in simulator flight trainer operations. The tasks included describing the roles of instructors and operators in training and analyzing operating consoles relative to these roles. The study[1] reported that major changes in simulator operation had occurred over the years, particularly in terms of the increasing involvement of the IP and INFO. The study also pointed out some problem areas which could arise as a result of the increasing utilization of the cathode ray tube (CRT) display and the capabilities of digital computer technology. In addition, the need for clarifying the role of the SO was stressed.

At the time of the study, the development and implementation of the generation of trainers capitalizing on digital technology was just beginning. Thus only preliminary design data and specifications for such trainers were available for review. This generation of trainers is now in place and being utilized. They are typified by devices such as the 2F119, EA-6B Weapon Systems Trainer (WST); the 2F112, F-14 WST; the 2F114, A-6E WST; the 2F92, S-3 WST; the 2F111, A-7 WST and the 2F110, the E-2C WST. In addition for full systems simulation, most of the devices incorporate a motion platform and some form of visual simulation.

Some of the trainers of multi-place aircraft were also designed to function as part-task trainers, e.g., the flight simulation subsystem could be isolated and operated as an operational flight trainer (OFT) or the weapons simulation subsystem could function as tactics part-task trainer. In some devices, the subsystems could function simultaneously, e.g., the 2F92; in others only one subsystem could operate at a time, e.g., the 2F119.

The implementation and use of this generation of trainers has surfaced some problems, both in utilization and acceptance and in basic design features, especially of the operator interface - the instructor console. This has been evidenced by high instructor-student ratios, instructor training problems, requests for specialized instructor-operators, and low training time for scheduled hours. The problems appear to be particularly acute in terms of fleet squadron use. Fleet squadrons do not have the manpower to support training evolutions requiring high instructor-student ratios,

---

[1] Charles, John P., Willard, Gene, and Healey, George. "Instructor Pilot's Role in Simulation Training," Technical Report NAVTRAEQUIP-CEN 75-C-0093-1, Naval Training Equipment Center, Orlando, FL March 1976.

extensive instructor training and refreshing for those with low training return for the time expended.

Therefore, the NAVTRAEQUIPCEN initiated a task to review and analyze the problems in utilizing Device 2F119 (EA-6B WST). The task was to address both problems unique to the 2F119 Instructors Operating Console (IOC) as well as generic problems in utilization of this type of trainer. The task included structuring feasible solutions.

DEVICE 2F119 OVERVIEW

The EA-6B WST (Device 2F119) was designed to the characteristics of the ICAP version of the system. This system utilizes a four man crew consisting of a pilot and Electronic Countermeasures Officer (ECMO 1) in the front cockpit and two ECMOs (ECMO 2 and ECMO 3) in the rear cockpit. ECMO 1 functions primarily as a radar navigator and communications jammer; ECMOs 2 and 3 operate the primary tactical jamming system.

Readiness training is conducted at NAS Whidbey Island by Fleet Readiness Squadron VAQ-129. In addition to Device 2F119 for ICAP training, a tactics part-task trainer (Device 15E22) is used for ECMO rear cockpit position training.

Device 2F119 incorporates a full-crew station (front and rear cockpits) on a six-degree of freedom motion platform. A "four window" night visual simulation, and radar subsystem are also incorporated. Two major subsystems provide the simulation for training – a flight and a tactical system. The two systems can operate independently (but not simultaneously) as part-task trainers or they can be tied together in an integrated mode for a full mission trainer. The three modes will be referred to as:

a. Flight mode

b. Tactics mode

c. WST mode

Each mode of training has several submodes to support scenario development, training, system test, hard copy printout and replay. The submodes are independent, i.e., the trainer must be brought off off line and the new mode initialized.

Flight Mode. In the flight mode, the tactics portion of the trainer is inactive or off-line. The mode includes the following submodes of operation.

a. Operate mode – provides the normal student training mode with instructor/operators at the console. The mode includes options for manual operation, Computer Evaluated Mission (CEM), recorded demonstrations, and dynamic replay (up to 20 minutes).

8

b. Plan mode - provides for modifying software to change initial conditions, CEM and malfunctions. A submode provides for recording demonstrations.

c. Hard copy mode - provides for reviewing and outputting copies of displays "flagged" during training.

d. Critique mode - provides up to 2 hours replay of any instructor displays at selectable times and speeds.

e. DRED mode - provides for the daily readiness tests of the 2F119 system.

f. TEST mode - provides maintenance data for the 2F119.

The flight mode is controlled from the flight console. The ECMO 1 console can be activated in the flight mode.

Tactics Mode. In the Tactics Only mode, the flight portions of the trainer must be off line. The following independent mode of operation are available and activated from the tactics console. The ECMO 1 console can be activated in the tactics mode.

a. Operate mode - provides the normal training mode with instructor(s)/operator at the consoles. The mode includes an option for dynamic replay (up to 20 minutes).

b. Plan mode - provides for modifying software to change emitter characteristics, mission parameters, and display characteristics.

c. Critique mode - provides for up to 2 hours of replay of instructor displays at selected speeds and times.

d. Hardcopy mode - provides for review and output of instructor displays "flagged" during training.

WST Mode. The integrated or weapons system mode consists of three functional submodes.

a. WST operate mode - provides for linking the tactics and flight simulation subsystems for normal full-system training. All of the consoles are activated and the ECMO 1 console can operate in either a tactics or a flight console mode. The flight console has primary control in terms of initializing the trainer. Dynamic replay of up to 20 minutes is available.

b. Critique mode - provides for up to 2 hours replay of instructor console (all consoles) displays at selectable times and speeds. Replay start and freeze are controlled from the flight console.

c. Hardcopy mode - provides for review and output of instructor displays flagged during training.

Note: Integrated mode software is developed or modified under the plan modes independently for flight and tactics functions.

Figure 1 depicts the overall installation of Device 2F119 and relates the major functional components of the system.

Figure 2 highlights the instructor console area. The console includes six CRTs, three for the flight instructor, one for the ECMO 1 instructor, and two for the tactics instructor. Each of the three instructor consoles includes besides the CRTs:

a. An Alphanumeric Keyboard (ANKB). The keyboard is a typical computer keyboard device (Appendix A, Figure A-1)

b. A function keyboard (FKB). The keyboard incorporates a cardboard overlay to designate key functions for each mode of operation and provides a 4 x 8 matrix of keys. The flight console overlays are:

    (1) Flight Operate

    (2) Plan/DFG

    (3) Plan/Demo

    (4) Display Printout

    (5) Test

    (6) DRED

The tactics console overlays are:

    (1) Tactics Only Operate

    (2) Tactics WST Operate

    (3) Tactics Plan

    (4) Tactics Only Critique

    (5) Tactics WST Critique

    (6) Tactics Hardcopy

The ECMO 1 FKB accepts either flight or tactics overlays.

c. Aircraft/communication Control Panel which includes altitude, heading, and speed slew controls (except ECMO 1 panel) and communications override, ICS, radio and volume controls.

d. Trainer Central Panel. Each console panel is slightly different but in general provides controls for Freeze, Emergency Stop, Plan mode activate and indicators for Crash and Oxygen Failure. The flight console panel includes controls for special effects and aircraft start and launch functions.
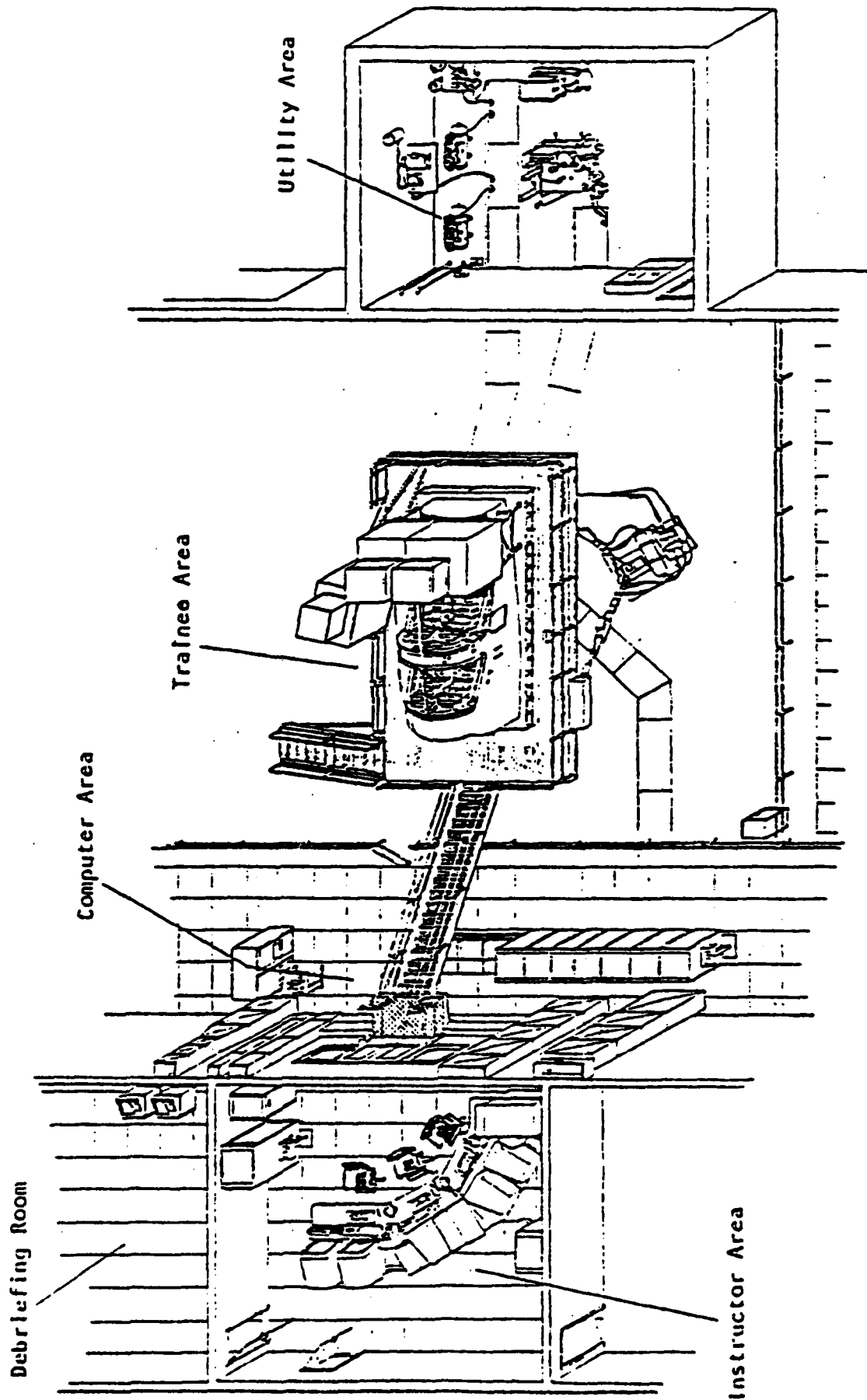
Utility Area

Trainee Area

Computer Area

Debriefing Room

Instructor Area

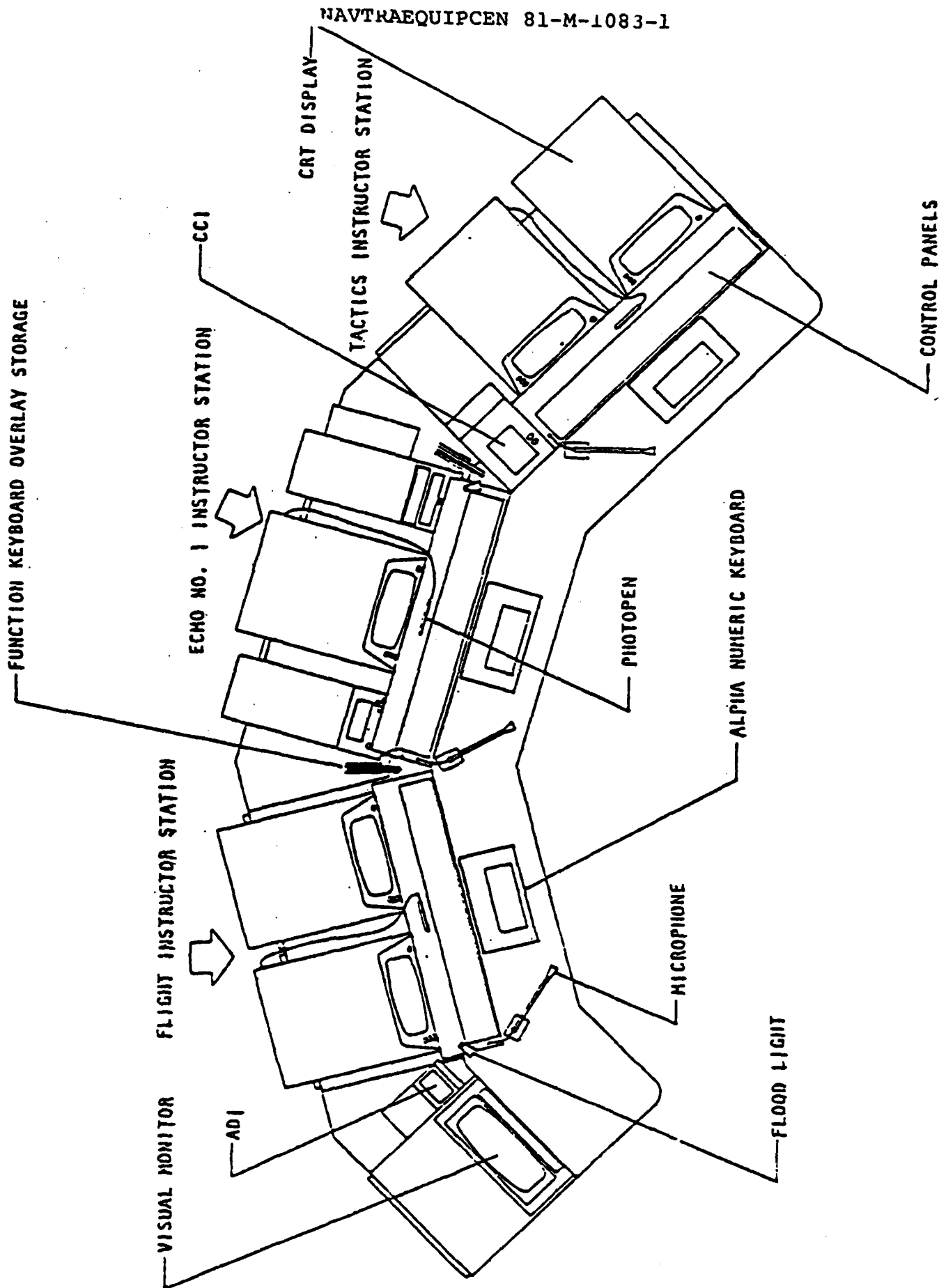Figure 1. EA-6B Weapon System Trainer (Functional Areas)

Figure 2. Instructor Console

e.   Mission Control Panel (Flight Console Only.)   The mission
     control panel provides controls for selecting and initia-
     ting demonstrations, initial conditions, and programmed
     missions.

f.   Repeater Indicators.

     (1)   Flight Console - A repeater attitude indicator is
           provided at the flight console (See Figure 2).

     (2)   ECMO 1 Console - A repeater radar display indicator
           unit (with instructor control selector) and visual
           display unit for the ALQ-92 and ALQ-99 are provided
           (see Figure 2).

     (3)   Tactics Console - A computer control panel (CCI)
           with instructor control option is provided (See
           Figure 2).

In summary, the flight and tactics instructor consoles utilize
CRTs for display of simulation and trainer cockpit displays and
cockpit control configuration. A function keyboard and alphanumeric
keyboard are used for system control and management with a light
pen available for CRT control use.

Displays. Table 1 lists the displays which are available at
the flight console (and ECMO I console when in the flight mode).
The displays can be transferred from the flight console to a
designated tactics CRT.

TABLE 1.   DEVICE 2F119 FLIGHT DISPLAY OPTIONS

Title	# Pages	Title	# Pages
1. Display Index	1	16. Terminal area	1
2. Initial Conditions Index	1	17. ACLS	1
3. Initial Conditions	10	18. GCA/CCA	1
4. Pilot Instrument Monitor	1	19. CEM Index	1
5. Pilot Console Monitor	1	20. CEM (Alphanumeric)	variable
6. ECMO 1 Monitor	1	21. CEM (Graphics)	1
7. Procedures Monitor Index	2	22. CEM Summary	1
8. Procedures Monitor	99	23. Demo Index	1
9. Malfunctions Index	1	24. Demos	10
10. Malfunctions	13	25. DRED	1
11. Input Codes	2	26. Visual Status Monitor	3
12. Function	10	27. Graphics Test Display	2
13. Parameter Recording	1	28. Memory Monitor	3
14. Cross Country	1	29. System Time	5
15. Hostile Environment	1	TOTAL	167

Display numbers 12, 25, 27, 28 and 29 are used primarily by key maintenance personnel. In addition to these, tactics displays (see Table 2) can be transferred from the tactics console to a flight controlled CRT.

Table 2 is a list of displays available at the tactics console.

TABLE 2.   2F119 TACTICS DISPLAY OPTIONS

Name	No. Pages	Name	No Pages
1. Initial Operate	1	8. Detailed Effectiveness	17
2. Ownship	1	9. Bar Graph	1
3. Strike Group	1	10. Forward cockpit	1
4. Maneuverable Platform	1	11. DDI 1	1
5. Malfunctions	7	12. DDI 2	1
6. Active Emitter List	1	13. Aft Cockpit	1
7. Emitter Edit	64	14. General Effectiveness	1
		TOTAL	99

In addition, any flight display can be transferred from the flight console to a tactics controlled CRT.

UTILIZATION OVERVIEW

The 2F-119 is utilized by both Fleet squadrons and the Fleet Readiness Squadron (FRS) (VAQ-129). Most of the fleet use has been for procedures, instrument, Naval Air Training and Operating Procedures Standardization Program (NATOPS) and spin training although requirements for more extensive use are being developed. VAQ-129 uses the trainer primarily for pilot/ECMO 1 and full mission training.

Fleet Squadron Use. The projected utilization by Fleet squadrons (primarily ICAP equipped squadrons) will include the following:

a. Annual instrument training

b. Annual spin training

c. Night Carrier Landing Training (NCLT)

d. Mission training including radar and navigation (Radar/NAV)

e. Miscellaneous (Warm ups, etc.).

Spin, Radar/NAV and NCLT will also be available for EXCAP equipped squadrons. Current squadron requirements should average approximately two hours per day. Integrated hops require at least three hours (not including brief/debrief time); Part-task hops are scheduled for two hours plus briefing/debriefing time.

FRS Use. The FRS syllabus requires the following utilization of the 2F119, plus any warmups or reflys:

Pilot Training Events

a.	Procedures Training	(4 hops)
b.	Acrobatic/Spin	(1 hop)
c.	Radar/ NAV	(2 hops)
d.	NATOPS	(2 hops)
e.	DEFTAC/SPIN	(1 hop)
f.	Instrument Check	(1 hop)
g.	NCLT	(2 hops)
h.	Integrated Missions	(2 hops)

In addition, the pilots fly additonal non-graded hops in support of ECMO training. (Note: only one front seat student is graded on a hop.)

ECMO Training Events

a.	Procedures Training	(6 hops)
b.	Acrobatic /Spin	(1 hop)
c.	Radar/NAV	(2 hops)
d.	NATOPS	(2 hops)
e.	Integrated Missions	(5 hops)

In addition, the Tactics Only mode is utilized as a back up to 15E22 training events.

In summary, the 2F119 is utilized primarily as a part-task trainer for the front cockpit (pilot and ECMO 1) and as a mission trainer for the full crew.

SECTION II
APPROACH

GENERAL

A multi-faceted approach including observation and operation/ system analyses was utilized to identify problems and structure feasible solutions. In addition, the results of the earlier studies of the Instructor Pilot's Role were utilized as a point of departure. The instructor function set developed was also used in analyzing console requirements. The functions are listed in Appendix B.

SURVEY

Visits to NAS Whidbey Island were made to collect data on:

- current training syllabi (students and instructors)

- instructor/operator console use

- deficiencies and problems (reported and observed)

- trainer documentation

- user acceptance.

Personnel from the Wing, VAQ-129, operating squadrons, NAVTRAEQUIPCEN Field Engineering Office and Fleet Aviation Specialized Operations Training Group Pacific (FASOTRAGRUPAC) Detachment were interviewed. Training operations were observed. Training syllabi, grade sheets, guides, handbooks, "gouges" and other material utilized in training with Device 2F119 were reviewed. Training sessions were observed including operating procedures and problems encountered and the functional roles of instructors and operators were documented.

ANALYSES

Following data collection, analyses were completed to identify and structure:

- functions of the instructor(s) and operator(s) implicit in the design

- functions of the instructor(s) and operator(s) in ongoing training

- operating problems

- design deficiencies

- implementation problems.

Function flow diagrams and time line charts were developed, where required, to expose problems or verify data collected. The function flow diagrams developed by Charles in the earlier study were used to structure the overall analyses. The function flow approach relates the tasks involved from reviewing the objectives to debriefing of the student and staff.

The results of the analyses were then categorized under two types, namely:

- Device 2F119 design deficiency

- Device 2F119 utilization problems.

Feasible solutions were developed. In addition, the design problems were subsequently reviewed for general application to other trainers and trainer procurements.

SECTION III

RESULTS

GENERAL

The results of the study of the Device 2F119 Instructor Console and its operation will be presented in the following order and topics:

a. current operation of the 2F119 Instructor Console

b. basic design deficiencies

c. functional design deficiencies.

The current operation of the 2F119 will cover the manning of the consoles for the different types of syllabus events and variations in operations observed. In addition, the actual operation will be contrasted with the functioning implicit in the design.

Basic design deficiencies will consider both static and dynamic problems. The static problems are primarily basic human engineering defects in layout and display and control design. Dynamic considerations address the interactions between displays, controls, instructor stations, and design functions.

Functional design deficiencies consider the generic training functions and trainer design. In this case, the functions outlined in the earlier instructor console study (see Appendix B) will be utilized.

CURRENT CONSOLE OPERATION

Manning of the instructor consoles of the 2F119 varies as a function of the syllabus. As discussed in the Introduction, Device 2F119 is used primarily in two modes, the Flight Mode and the Integrated or WST Mode, and secondarily in the Tactics Mode as a backup to Device 15E22 PTT. The Flight Mode supports front cockpit training consisting mainly of aircraft systems procedures (normal and emergency), radar/navigation, instrument and NATOPS procedures training. The Integrated Mode provides for full system and mission training and requires that the crew be "position" trained. The backup Tactics Mode provides ECMO training in operation of the Tactical Jamming System (TJS).

FLIGHT MODE

The Flight Mode Training events provide training for both the Pilot and ECMO 1 positions. They are typically conducted by one Flight Console instructor and a simulator operator. The Flight Console instructor utilizes the visual display CRT and the

two flight CRTs. The simulator operator normally sits at the
ECMO 1 instructor console and utilizes that CRT and keyboards
to support the instructor. Although the radar subsystem was
"down" during the survey, instructor personnel interviewed had
experienced no problems in manning the consoles in a similar
manner when the radar was operative. The role of the simulator
operator varied from a standby maintenance function to full
system operator in response to instructor requirements. The role
varied not only as a function of console operating skills of the
instructor, but equally with the instructional approach of the
instructor. Where the instructor was intimately familiar with
the 2F119 systems and operation and preferred to manipulate the
trainer to achieve the training objectives, training was accom-
plished. Similarly, where the instructor functioned more in a
student monitor mode and depended upon a proficient operator
for simulator control, training was effective. However, when the
other two conditions occurred, i.e., where either an instructor
operating in the "manual" mode or a simulator operator support-
ing an instructor operating in the "monitor" mode were not con-
sole proficient, training suffered.

INTEGRATED MODE

The Integrated Mode events are conducted with three instruc-
tors and an operator(s). The three consoles i.e., Flight Console,
tactics console and ECMO I console are manned by qualified intruc-
tors. However, the ECMO 1 console instructor functions as a train-
ing problem controller or scenario director. The task is major
since he must coordinate the efforts of the flight and tactics in-
structors to achieve full mission training. Display/control prob-
lems which will be reviewed in following sections complicate the
task. Differences in flight and tactics instructor console
operating proficiency and instructing preference or mode further
compound the problems. Integrated missions observed typically
utilized about half the scheduled time, the remainder was spent in
initializing the mission and getting the entire system, i.e.,
simulator, students, instructor and operators coordinated to the
extent required. Most of the major problems observed were caused
in the design. Inter-instructor communications are difficult. The
ICS is not easily used and voice communication is difficult because
of console spacing and ambient noise levels. No, or very little
information is available to the instructor team on mission status -
each console typically has only part of the picture and unfortun-
ately the problem controller has severely limited display capa-
bility (one CRT). He must share flight and tactics displays which
places an additional burden on the other instructors to maintain
displays needed by the problem controller rather than those desired
by them. Preparation support from the trainer is minimal. There-
fore instructor team planning and briefing is time-consuming and
almost solely dependent on the efforts of the problem controller.
Any last minute changes in instructor personnel literally pre-
clude a coordinated mission exercise, i.e., the mission breaks
down into an initial flight phase, an ECM phase, and a final

19

flight phase. Slewing of aircraft may even be required in the tactics phase to achieve ECMO training.

The simulator operator(s) support is either very limited or is accomplished by telling the instructor what to do or leaning over the instructor and taking control of the keyboards (and displays if required). Neither is conducive to timely operation or coordinated mission implementation.

The problem controller instructor is the key to mission training. Yet neither the trainer or the console position is designed to support this function. Successful integrated missions were observed but they depend heavily upon instructors with extensive trainer experience (at least 6 months) and especially on the dedication and motivation of the problem controller. He probably must have at least a year's experience with the simulator as well as academic and flight instructing experience. In addition, considerable preparation (planning) time is required.

The training functions which are not supported by the 2F119 place further demands on the instructor staff. For example, all inter-ship/strike/etc. communications are simulated manually requiring considerable time and "pencil record keeping", primarily by the flight instructor and problem controller. Briefing is all manual. Debrief is manual since the "Critique Mode" requires trainer time. In addition, the instructor consoles are far from optimal for debriefing students. Mission and crew evaluation requires instructor "conference" and joint review of the results since there is no instructor "mission" results review incorporated in the trainer. Critique requires reconfiguring the consoles, identifying the mission time or segment to be replayed and selecting displays. There is rarely time for the instructor to attempt such a review within the scheduled time. To implement critique requires manning at both flight and tactics consoles since flight has "on-line" control.

TACTICS MODE

The Tactics Only mode of training is utilized primarily as a backup to the PTT Device 15E22. When utilized, the tactics console and the ECMO I console (in the tactics mode) are manned by an instructor and operator. For basic crew station familiarization events, the instructor stands alongside the rear cockpit on the platform. No communication or simulator controls are available nor is a "jump seat" available.

Serious display and control deficiences handicap the tactics instructor and will be reviewed in detail in the following sections.

TRAINER SUBMODES

Usage of the various submodes designed into the trainer is limited. The available modes include:

- Dynamic Replay

- Critique

- Print

- Plan

- Demonstration

- Computer Evaluated Mission (CEM)

- Parameter Record

Dynamic Replay. This submode provides replay of up to the last 20 minutes of the training event including visual, motion and voice. Except for limited usage in NCLT events, the mode is rarely used except to reset to initial conditions (if within the 20 minute replay period) using freeze and flyout. Replay is not considered effective in pilot training at the FRS level; is considered even less important to tactics training (ECMO 2 and 3); and is difficult to use. The display/control problems will be reviewed in latter sections. Flyout from other than the end of replay can pose aircraft configuration problems, i.e., throttle, slats, flaps, stores, etc. may not agree with the flyout state. No data are available to the instructor on "mismatches". Time consuming verbal checks or "trial and error" must be used. Communication record and replay are not used at all.

Critique Mode. This submode provides up to two hours replay of instructor displays at selectable speeds and times or to "flagged" points in the event. Display/control problems create implementation problems and will be reviewed in a later section. The mode is rarely used since it:

a. requires trainer time, i.e., the trainer cannot be used for training when critique replay is being used:

b. and only the instructor consoles are available for replay. They are not well designed for up to two hours replay for training. There are no additional seats - viewing the CRT's requires standing. Selecting displays (other than those utilized during the mission) requires careful annotation to keep replay meaningful and directed to the training goal. While other CRTs could be utilized the physical separation of flight CRTs from tactics CRTs precludes such use.

Print Mode. This submode provides for copies of up to 50 displays flagged during training. It is rarely used. The print mode is a non-training mode. Thus hardcopy generation must be performed after training or training stopped. The display to be

printed must have been displayed on a CRT. Print time is relatively long and is accomplished in the computer spaces, one floor below the consoles.

Plan Mode. The submode consists of two modes. Plan mode/Demo provides for recording, review, and storing of demonstrations (up to ten). Since demonstrations are rarely used (except for system capabilities) the mode is rarely used.

Plan Mode Disc File Generation (DFG) provides for creating or modifying initial conditions, displays, missions, radio facilities, CEM's and malfunction values. It is accomplished using punched cards. Extensive experience is required to utilize the mode effectively. Few instructors have the skill required or the time to develop the skill and utilize the capability. A very small cadre of instructors developed the existing training programs. Maintaining the required skills in the staff is a problem because of instructor rotation. The mode also utilizes training time. Since a considerable period of time is required to PLAN, it must generally be done after training hours or whenever time can be made available.

Demonstration Mode. This mode is not utilized except for trainer capabilities demonstrations. Instructors do not feel demonstrations contribute to replacement aircrew training.

CEM. CEM is a submode of the operate or training mode. It provides for computer tracking of crew performance against a stored mission. Special displays and printouts are available. The submode is not utilized for several reasons. Pre-programmed missions (to the detail required) are not part of the syllabus. Creating missions to the detail required is laborious. Finally managing the conduct of a CEM is difficult and requires training and frequent use to maintain proficiency.

Parameter Record. This is also a submode of the operate or training mode. It provides for monitoring of up to 18 parameters with printout in strip chart format of results. Display and control design problems seriously complicate usage. The problems will be reviewed in a later section. More importantly, the data are output in essentially analog fashion and are of little use to instructors with limited time to scan strip charts or raw data plots.

BASIC DESIGN DEFICIENCIES

The instructor console design was analyzed both in terms of basic human engineering criteria and in terms of operations. The first looked at display/control layout and design in terms of the generic human operator; the second looked at the console in terms of the actual user and operations.

Basic Human Engineering Problems. A wide variety of human engin-
eering deficiencies were isolated during the study. Some have
relatively minor impact on system effectiveness. However, human
engineering deficiencies are generally cumulative and even minor
problems will have an incremental effect on use. The problem
will be discussed under the following topics:

    a. system layout problem

    b. console design problem

    Layout Problems (LP). Figure 1 illustrated the 2F119
functional areas and related the location of the three areas of
primary concern, viz. instructor consoles, briefing room and
mockup areas. Figure 3 expands the view of the instructor
area.

    The trainer or mockup area is a large high bay which also
houses the A-6E WST and NCLT mockups. Lighting in the area
varies from moderately low levels to high levels for maintenance
and repair activities.

    LP-1. The only student access to the training mockup is
through the instructor area. Both the passageway and the
briefing room are well lighted. This overall arrangement re-
sults in:

        ● bright light falling on instructors faces whenever
anyone enters the area

        ● congestion in the console area, especially the
tactics instructor area at the beginning and end of each train-
ing period where two sets of instructors and students are utili-
zing the areas. The problem is particularly severe for inte-
grated missions where over 10 to 12 persons may be in the area
while the instructor team is preparing for the event.

        ● "compromise" of the training scenario since the
students can hardly avoid seeing the CRTs as they pass through
the instructor area on the way to the mockup. (Normally the
training event is being or has been initialized by the time the
students are passing through.)

    LP-2. The instructor area lighting controls are on the far
wall in front of the consoles. Thus, any lighting adjustments
needed can only be made by the instructor leaving his station
and walking around the console to the switch plate on the wall.
Lighting adjustment is not rheostat controlled.

    LP-3. Lighting from the mockup bay falls on the displays.
If bay lighting intensity is high for maintenance on the other
trainers, the 2F119 CRT displays can be "washed out." Plastic
film filters have been installed on the windows to reduce the
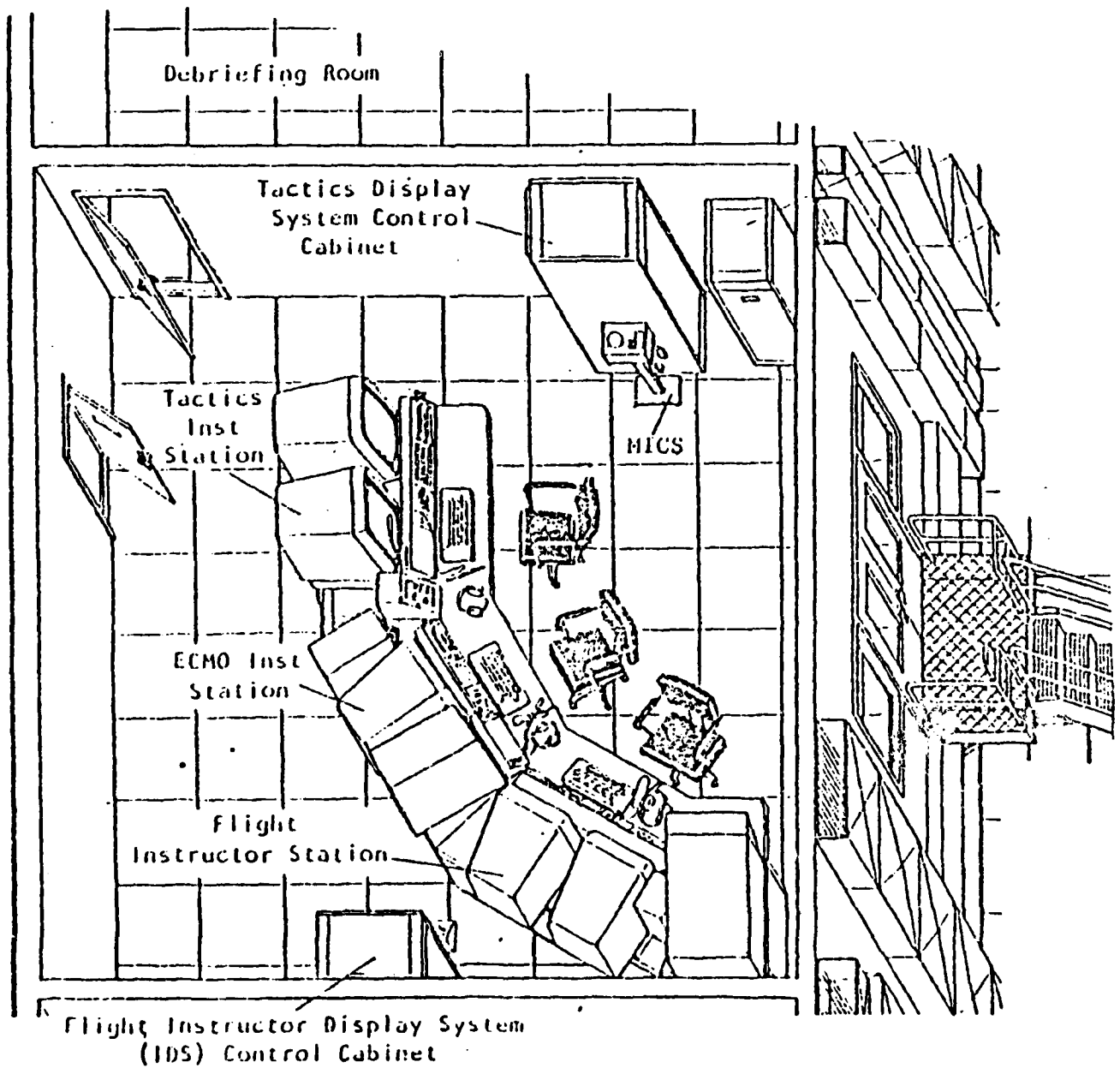problem.

Figure 3. Instructor Area

LP-4. No indications of which trainer interlock switches were open was provided. The ten interlocks are physically relatively widely dispersed. A local change installed an indicator light for each interlock. Considerable time is saved in isolating which ready condition has not been met for motion system activation.

Console Design Problems. (CDP) These problems refer to those design features in basic display and control layout and characteristic features which are interface problems. They include display control arrangement, lighting, readibility, operability, etc. The problems will be discussed in terms of overall display/control content and arrangement and then in terms of individual instructor station beginning with flight, ECMO and finally tactics. Figure 3 relates the console and the three instructor stations. Problems common to all consoles will be reviewed first followed by specific console problems.

CDP-1. Inter-instructor communications are difficult. The three instructor stations are too separated to permit direct voice contact or to share displays. The trainer intercom capability is not utilized for inter-instructor communication even though the console provides the capability by override switches on the instructor station communications control panels. The necessary and frequent shifting of communications between instructor positions air crew positions, and "simulated" radio facility communications, practically precludes use of these switches. A total of 10 switches control the flight instructors ICS. All would have to be checked prior to inter-instructor use to ensure desired communication e.g., de-selecting 4 aircrew positions and 3 radio transmit positions.

CDP-2. Instructor microphone operation utilizing foot switches is unsatisfactory. The foot switch is either not immediately available or is accidently pressed. Relocating foot switches to the console desk edge is an unsatisfactory solution. (Note: stand microphones with a built in bar switch have been recently added.)

CDP-3. Inadequate readily accessible storage for documentation provides no ready access storage for regularly used training materials, especially NATOPS manuals such as the PCL, Flight and Tactical Manuals, syllabus, scenarios, frequency cards, etc.

CDP-4. CRTs are difficult to share because of physical separation and console "wrap" angles at the 3 instructor positions. Sharing of CRT displays is essential in the integrated modes and desirable in the independent modes. The problem is especially critical for the problem controller who utilizes the ECMO-1 position with only one CRT and is forced to share flight/tactics CRTs.

CDP-5. CRT displays are recessed too far for light pen use. To reach the top line of the display, most instructors must stand to touch the CRT face plate with a light pen. In addition, the angle of the display results in excessive parallax for using light pens.

CDP-6. Light pens are too unreliable a means of data entry for time sensitive inputs such as malfunction insert, hostile environment activation and emitter control. In addition, time required to "hook" detracts from instructor monitor function at these critical periods.

CDP-7. Confusion results in attempted use of light pen on "transferred displays." For example, a flight display can be transferred to the ECMO 1 console by the flight instructor, but the light pen cannot be used on that display, although data can be entered via the keyboard.

CDP-8. CRT's are too distant for required readability especially of ownship and other map displays, and cockpit panel displays. Instructors must lean close to the display to monitor and use it with resultant problems in use of the other displays and controls.

CDP-9. Alpha Numeric Keyboards (ANK) are unsatisfactory instructor input and control devices. The majority of marks and keys are not used by instructors. The keyboards require excessive use time. Knowledge of operation procedures is needed. They also require prime console space. Few instructors utilize or are aware of the control features available through the ANK. (See Appendix A)

CDP-10. Control panels are poorly lighted, especially the visual system panel. The flight instructor must literally utilize the light's test button to illuminate the control switches to identify them. Flood lighting as designed was inadequate. Grimes lights have been added to relieve the problem.

CDP-11. Inconsistent functioning of similarly labeled and lighted controls leads to confusion. "On-line" at the tactics station precludes operation in the tactics mode. Use of same shape and lighting for indicators as well as switches leads to confusion, e.g., STUDENT, XMTG, CRASH, OXYGEN FAILURE are indicator lights while most other similarly shaped "lights" are push button switches.

CDP-12. CRT selection and CRT display anomalies are confusing. For example, (a) any station can transfer a display to another either purposely or accidently, (b) zero selection at flight sets up a fixed set of displays, (c) certain displays come up automatically (terminal area) and (d) initializing brings up a specific set.

CDP-13. No readout of operating mode is provided unless the legend plate is read in detail, e.g., TACTICS only and WST modes overlays read TACTICS ONLY OPERATE and TACTICS WST OPERATE. This has resulted in a wrong overlay being installed accidentally.

CDP-14. Overlay cards are badly organized. On some displays scale factors are vertically arranged (TACTICS operate) and on others horizontally (Flight operate). Control functions and display selection are intermixed, e.g., flight operate, auto approach inhibit, CRT store, etc.

CDP-15. Console communications system feedback is a problem. It can be difficult to isolate the offending speaker or microphone.

Specific problems at the individual consoles will be reviewed next.

Flight Instructor Station Problems. Figure 4 outlines the flight instructor station.

CDP-16. The visual view monitor selector is unlighted. Under normal lighting conditions, the setting cannot be read. The problem is critical in utilization of the hostile environment for the visual display provides the only positive indication of the results of light pen activations of weapons. (See Appendix A)

CDP-17. The alpha-numeric readout of flight instrument indicators, (Figure 5) and console indicators (Figure 6) and control positions is unsatisfactory. Extensive training and practice would be required for the instructors to become proficient in the use of these displays. Furthermore, it is conceivable that a negative transfer effect to flight instruction could occur. (Note: a change request to incorporate a set of repeater basic flight indicators was initiated by VAQ-129.)

CDP-18. The Instructor Mission Control Panel (Figure 7) is poorly arranged. Selection should precede ENTER control. "Error Print Interval" controls are not used.

CDP-19. The Instructor Training Control Panel (Figure 8) is badly arranged and unrelated. Similar functions are widely separated, e.g., ON LINE, FREEZE and MOTION controls. Indicators and switches are identical in appearance. The oxygen failure indicators are not used. Rough Air is not used except for special effects such as near weapons hit.

CDP-20. Monitoring of student transmitter and channel choice is difficult. Indicator lights on the Communication Control Panel (Figure 9) momentarily show the radio being used. The channel or frequency can only be gotten from a) the pilot's console monitor display, or b) the map displays and communication switch settings can only be gotten from the pilot's console monitor display.

VISUAL MONITOR

ADI PANEL

FLOOD LIGHT

MISSION CONTROL PANEL

MICROPHONE

ALPHA NUMERIC KEYBOARD

SPEAKER

CRT DISPLAY

ASH RECEPTACLE

AIRCRAFT/COMM CONTROL PANEL

CONTROL PANELS

TRAINER CONTROL PANEL

ICS RECEPTACLE, INSTRUCTOR

ICS RECEPTACLE, OBSERVERS

UTILITY PLUG

VISUAL SYSTEM CONTROL PANEL
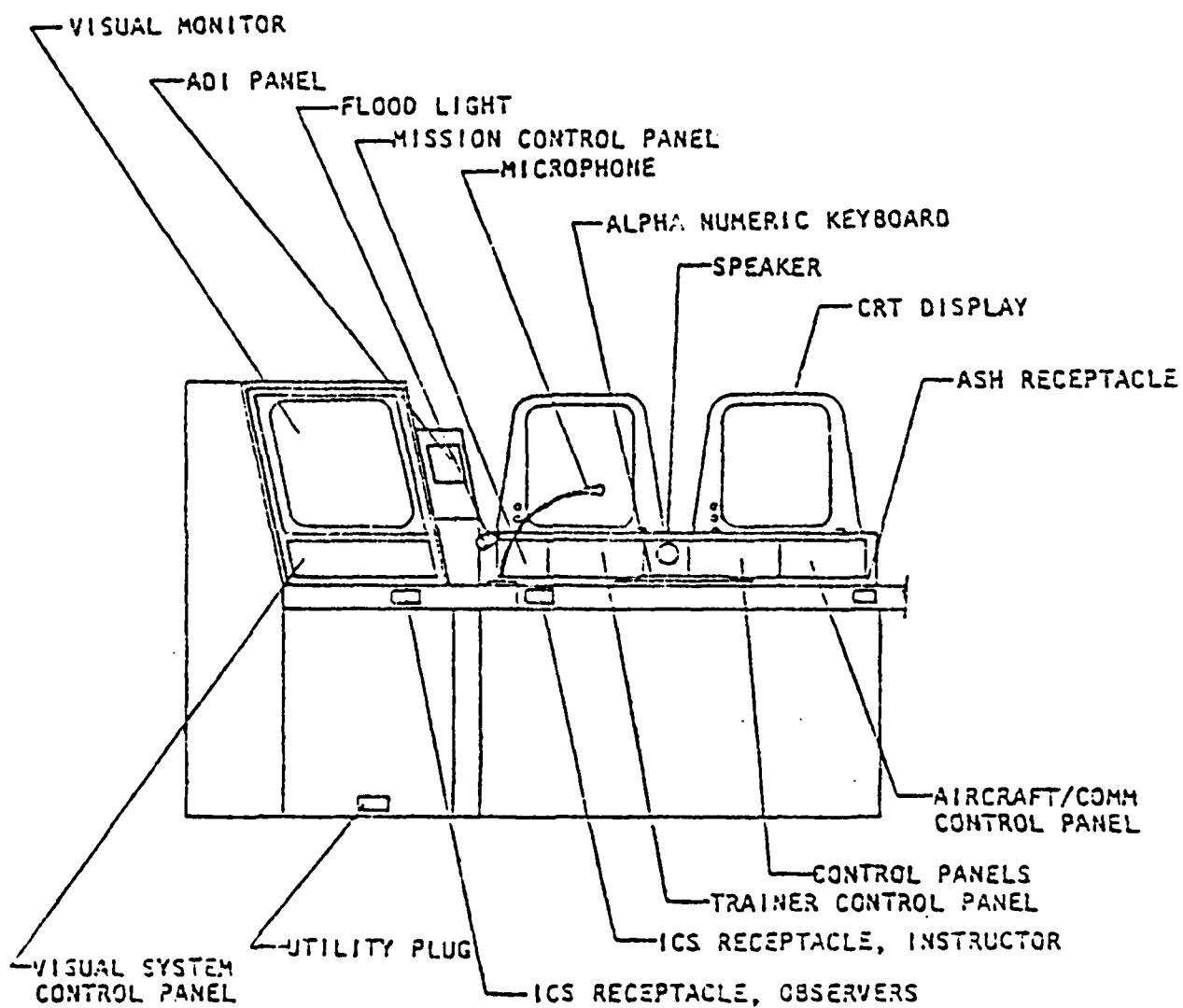
Figure 4.   Flight Instructor Station

28

PILOT'S INSTRUMENT MONITOR

Figure 5. Pilot's Instrument
Monitor Display

PILOT'S CONSOLE MONITOR
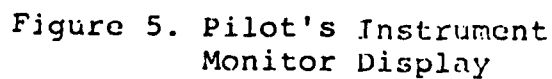
STALL WARNING	ADEQUATE

FUEL MGMT

REFUELING	OFF
BOOST PUMP TEST	OFF
TANK PRESS	NORM
WING DROP TANK PRESS	NORM
WING	NORM
FUS	NORM
FUEL GAGE	NORM

BLEED AIR

NUU	
L ENG	
R ENG	

ASSIST SPIN RECOVERY

EMER FLAP	OFF

APC	
AIR TEMP	
FLAPERON POP-UP	
ANTI-SKID	ON
HOOK BYPASS	TOUCH GO
SPD BRAKES TEST	OFF
EXTERIOR LIGHTS MASTER	ON
COLLISION LIGHT	ON
TAIL LIGHT	BRT
TAXI/PROBE LIGHT	ON
WING LIGHTS	BRT
FORMATION LIGHT	BRT
PYLON	OFF
SLEU	
RADAR ENTER	
OXYGEN	
SEL STORES JETT	SAFE

CABIN DUMP	
UHF ANT	
TACAN ANT	FWD
ADF	

RADAR BEACON PWR	PWR
MODE	ACLS
AIR COND CKPT	
AIR COND MSTR	
MAN RAM AIR	
AUTO TEMP	
EQUIP COOL MSTR	

ACLS

TEST/NORM (RJ)	NORM
DATA LINK	ON
FRED	3.8

ARA-63

CHANNEL	7
POWER	
BIT	

DISPLAYS

VERT REF	
ACLS	

CHAFF

PACK 1	8
PACK2	8
EMIT	OFF
AUTO/MAN	DECM	OFF	AFT

POWER	TEST

L GSN	R GSN
L ENG	R ENG

AUTOPILOT	OFF
ALT HOLD	OFF
MACH HOLD	OFF
ACLS	NORM
STAB AUG	STAB AUG

UHF	PRESET
	MAIN
FREQ	(2)

IFF-SIF

MASTER	
CODE	
RAD TEST	
MODE 1	
MODE 2	
MODE 3/A	
MODE C	
MODE 4	
IDENT	

UHF 1	
UHF 2	
HF	
TAC/IFF	
CCM/IX	
WARN	
TIS	
ICS	

ICS	
AMPL SEL	NORMEN
MIC SEL	COLD

ENG ANTI-ICE	OFF
DEFOG	
WINDSHIELD	
PITOT HEAT	AUTO

WINGFOLD	LOCKUN

UHF	PRESET
	MAIN
FREQ	(3)

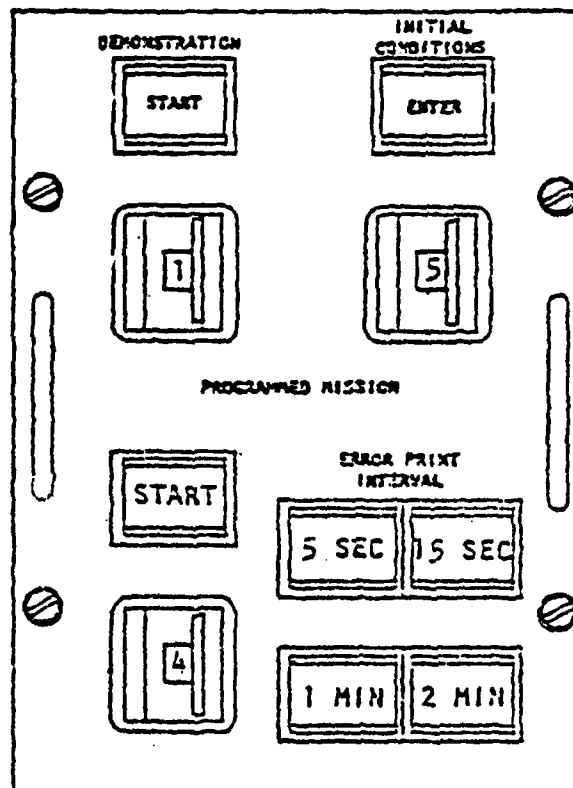| CCMP	
LAT	

Figure 6. Pilot's Console Monitor Display

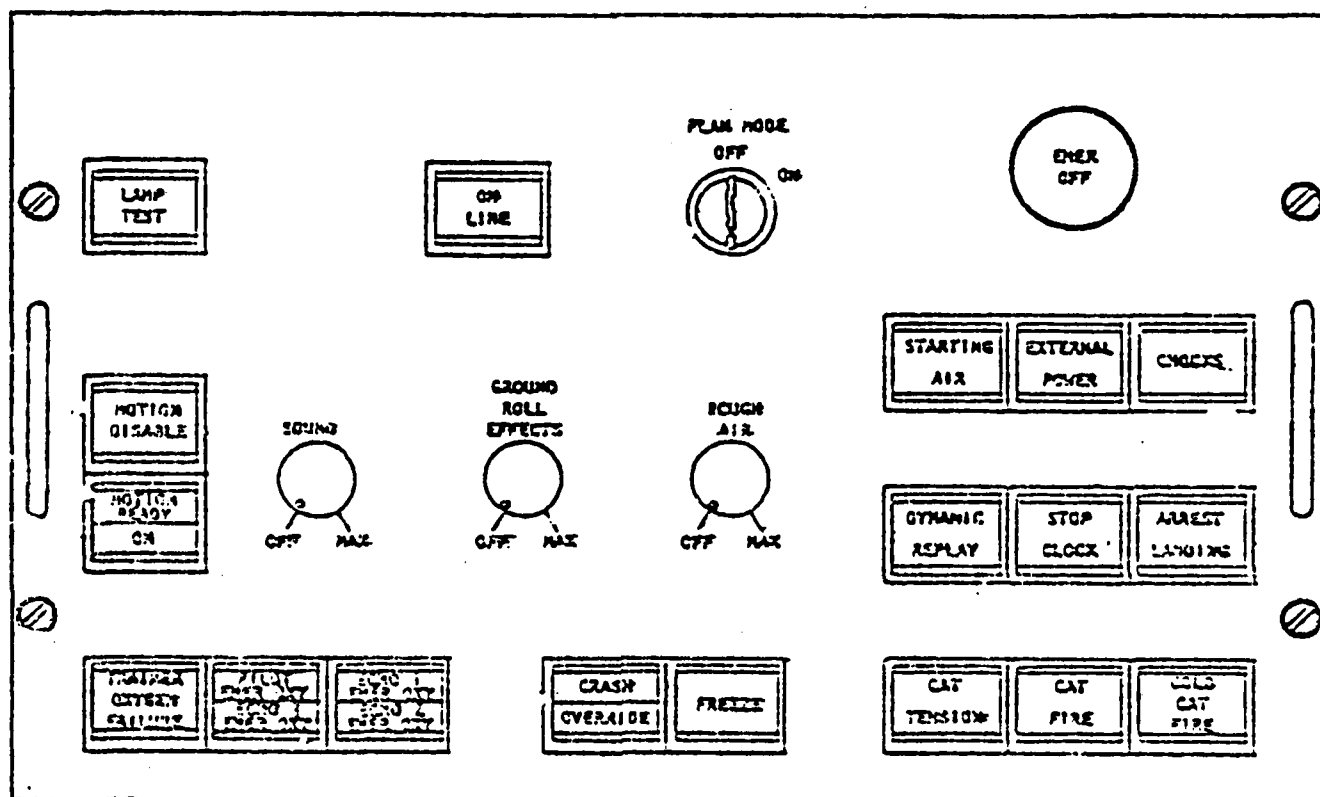Figure 7. Flight Instructor Mission Control Panel

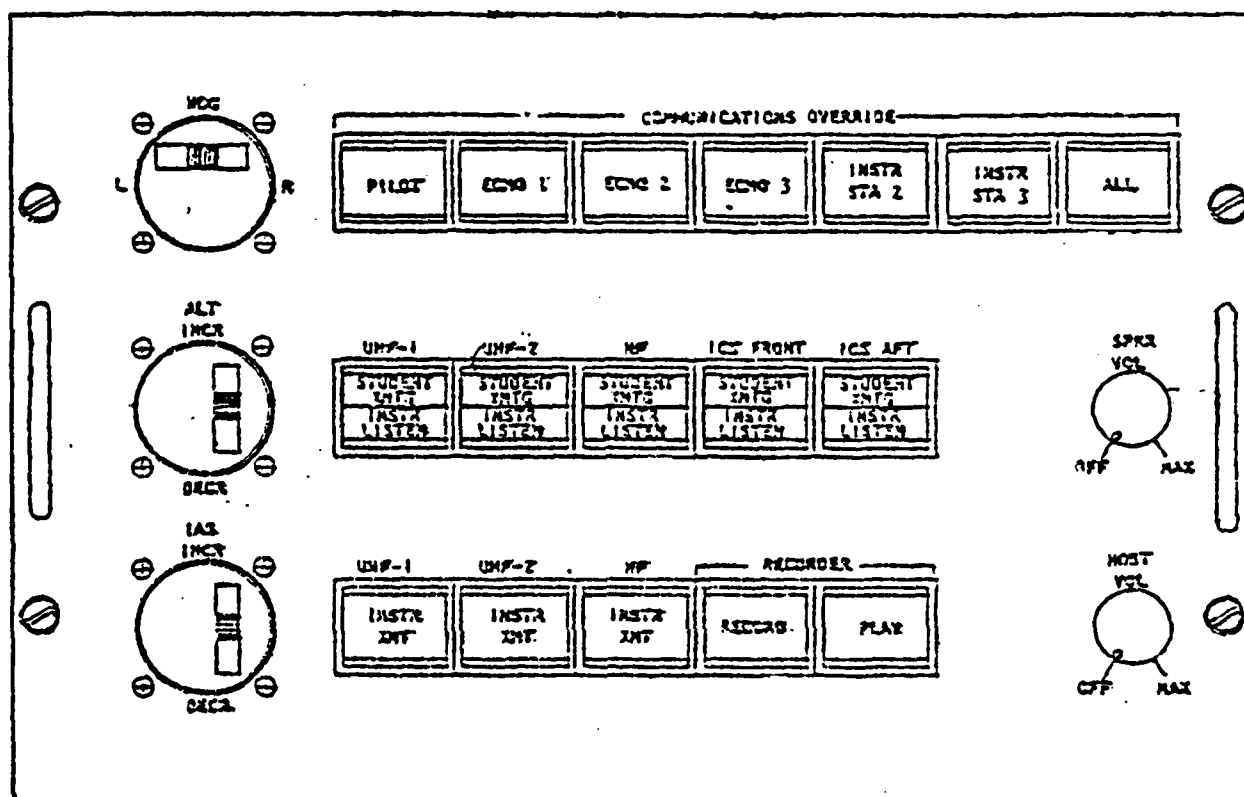Figure 8.   Flight Instructor Trainer Control Panel

Figure 9. Flight Instructor Aircraft/Communication
Control Panel

CDP-21. Automatic terminal area display selection is not used as mechanized. The automatic feature creates two problems. First the terminal area closest to the aircraft is displayed regardless of plan; second the display always comes up on CRT-1 regardless of CRT switch selection. As a result, the AUTO APCH INHIBIT switch is always used.

CDP-22. No indication of runway heading or distances were designed into the terminal area map. (These changes have been locally implemented.)

CDP-23. The GCA/CCA display does not provide adequate resolution near decision height. The display is linear out to 6 NM. with the result that the last critical mile is inadequately displayed.

CDP-24. The GCA/CCA display originally provided only alphanumeric data on key aircraft parameters and no information or configuration, engine performance or weather. (A local change to the display was implemented which provides the required flight engine data as well as switch action, weather and an active malfunctions list.)

CDP-25. GCA/CCA message data are adequate. Message timing is unsatisfactory for final GCA approach control. (As a result, messages are not utilized except for vocabulary standardization.)

CDP-26. The ACLS Display is "carrier up" oriented. As a result pattern headings must be mentally computed by the instructor. Although flight, engine, configuration and weather data have been added to the display, no indication of heading is available in the display. Therefore, the instructor must remember last heading assigned and assume aircraft has complied.

CDP-27. Procedure monitoring was originally available for only one normal or emergency procedure at a time and was lost if the procedure monitoring display was even momentarily deselected. (A local change to permit simultaneous monitoring and recall of up to four procedures has been incorporated.)

CDP-28. The Hostile Environment display is difficult to call up and to correlate with the tactical environment. Call up requires that a) the cross country map in the 75 x 75 mile scale be displayed, b) the CRT select switch be set to that CRT, and c) the instructor enter "VE 1 CR" at the ANKB. Once overlayed, the locations of the SAM/AAA which are fixed in the 75 x 75 mile area are difficult if not impossible to correlate effectively with aircraft heading, and the tactical environment, especially the actions of the EW crewmembers. In addition, the instructor must utilize the visual display for feedback which requires that he select the proper view (left side, left forward or forward) for the launch locations. CRT No. 2 is normally used since it permits the problem controller at the ECMO1 position to attempt correlation of the tactical environment. This requires the flight

instructor to scan across the entire flight instructor console
to activate and monitor hostile effects. (See Figure 4.)

CDP-29.   Using map slew with the Hostile Environment dis-
play overlay on results in loss of the overlay. However, to re-
locate the aircraft relative to the hostile environment matrix
or to keep the aircraft in the 75 x 75 mile map area, the in-
structor must select MAP SLEW, redefine map CRT position using
the slew control and then re-enter "VE 1 CR" to overlay the
hostile environment overlay which now relocates all AAA/SAMS
(which are in fixed positions on the overlay). Thus the in-
structors must adjust to a new hostile environment with every
map slew operation even though the tactic environment of the
problem has not changed.

CDP-30. Map slew control display dynamics are unacceptable.
The map slew control results in step inputs with the last step
occurring after release of the slew control. It is virtually
impossible to achieve the slew desired, much less in any reasonable
time.

CDP-31. Critique replay must be initiated by selecting and
entering minutes of replay up to two hours. Yet mission time
is recorded and displayed in hours, minutes and seconds. Con-
fusion typically occurs since minutes entry is neither obvious
or specified.

CDP-32. Displays for LSO use in NCLT are inadequate. The
LSO has only the terminal area display available.

CDP-33. Approach plate data is not available on the displays
but is required for approach.

CDP-34. The DRLMS determines terrain crash conditions. The
instructor has no terrain information on map terminal area displays.
Therefore, he can vector the pilot into the terrain unknowingly.

CDP-35. Map and terminal area displays are labeled in latitude
and longitude. To employ the ANKB for recentering or relocating
display points, the instructor must relate scale factor and
changes into latitude and longitude. This is time consuming and
errors are frequent when used.

ECMO 1. Instructor Station Problems. Figure 10 depicts the
station with its single CRT and repeater radar scope, ALQ-92 and
ALQ-99 units. The communication control panel problems are the
same as discussed for the flight instructor's station. Switch
and console lighting problems, CRT position and light pen operation
problems are also the same. Since the station can function in
either the flight or tactics mode (but only one , the display
comments for flight and tactics apply.

Tactics Instructor Station Problems. Figure 11 depicts the
station with its two CRTs and Computer Control Indicator (CCI)

CRT DISPLAY

VDU, ALQ-92

VDU, ALQ-99

ECMO NO. 2
ECMO NO. 3

CONTROL PANELS

ALPHA NUMERIC KEYBOARD

INSTR CONTROL

DVRI, APQ-129

DRLMS DATA INVALID

FLOOD LIGHT

ICS RECEPTACLE, INSTRUCTOR

Figure 10. ECMO 1 Instructor Station

CRT DISPLAY

FLOOD LIGHT

ICS RECEPTACLE

ALPHA NUMERIC KEYBOARD
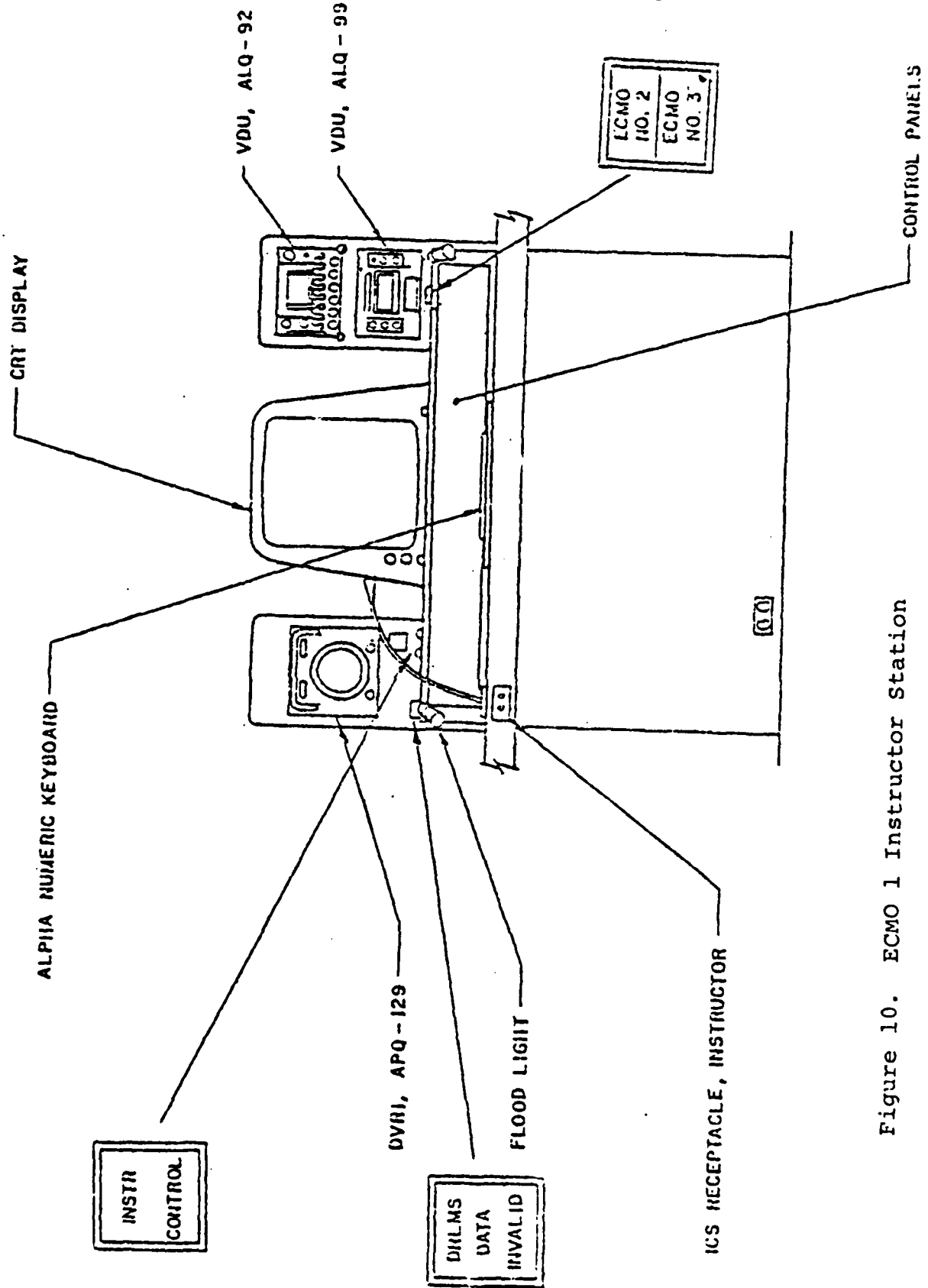
CONTROL PANELS

MICROPHONE

ICS RECEPTACLE, INSTRUCTOR
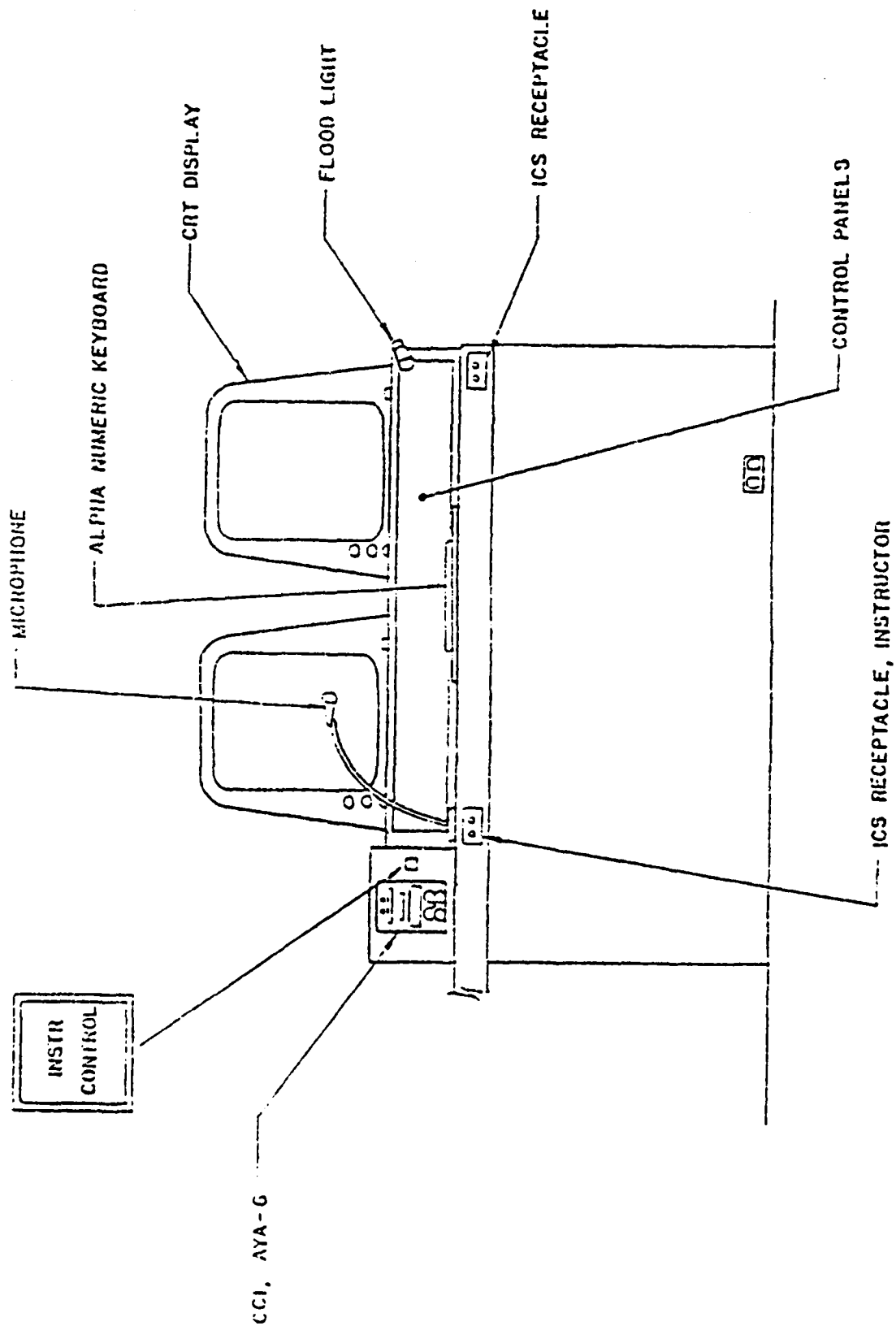
INSTR CONTROL

CCI, AYA-6

Figure 11. Tactics Instructor Station

unit and control switch. The same problems with CRTs, lighting, communication control, and ANKB exist that were discussed under the flight instructor console section. In addition, the following problems exist.

CDP-36. Only one Digital Display Indicator (DDI) can be displayed (on No. 5 CRT) at a time. Thus, only one ECMO can be monitored.

CDP-37. The DDI display is a repeater of the display selected in the cockpit. Thus, instructors cannot call up the other DDI displays needed to evaluate student performance.

CDP-38. Manual entry of LIST data as part of the training event consumes considerable training time (typically 15 to 20 minutes). Tape cassette loading capability should be incorporated as soon as it is available.

CDP-39. EA-6B aircraft heading is difficult to determine relative to jammer activity for evaluation purposes, even though displayed numerically at the bottom of the displays. Relative angles must be determined by the instructor.

CDP-40. The map displays (ownship, strike group and maneuverable platform) become very cluttered with data during most integrated missions. Edit capability to delete emitters of "low" interest (or retain high interest emitters) could reduce clutter and enhance use of light pens.

CDP-41. Emitter control is complex and requires several different display pages to implement. For example, the active emitter page summarizes emitter activity, but data on any specific emitter is available only on the emitter edit display (64 pages). Basic emitter control data required is emitter number, on/off, power and latitude/longitude.

CDP-42. The front and aft cockpit displays are in alphanumerics requiring the instructor "read" to determine control positions. In addition, some panel arrangements do not agree with aircraft arrangement. For example, the jammer status panel is arranged almost the opposite of the actual panel in the aircraft.

CDP-43. Jamming performance evaluation data is scattered across several display pages. A single display of key parameters for example, antenna aim, frequency, modulation, power and switch settings is required but is now only available from three display pages.

CDP-44. Communications audio background is difficult to simulate by instructor. Prerecorded message traffic is needed.

FUNCTION PROBLEMS (FP). The earlier study of the instructor consoles developed a set of generic functions involved.

in simulator supported training. These functions were used to review the operation of Device 2F119. The basic functions which will be reviewed are:

1) Prepare - assemble materials, review data, plan event

2) Brief - review event with student(s) and staff

3) Initialize - configure trainer, initialize system, establish readiness

4) Train - instruct, control simulator, monitor performance

5) Evaluate - diagnose student problems, evaluate proficiency

6) Debrief - review event with student(s) and staff

7) Manage data - update student file, staff, and simulator data

8) Develop syllabus - create/modify syllabus events, ICs, etc.

9) Train instructor - train IUT in console operation, simulator training

10) Student/Peer train - support practice sessions.

Prepare Function. The 2F119 does not support the prepare function as designed. The syllabus, lesson guides, scenarios, schedules are not stored in the system.

FP-1. Initial condition sets, malfunctions data, weather, emitter locations, radio facilities and related data are available on the 2F119 displays. If used, CEMs can best be reviewed on a CRT. Additional data could be stored in the system. However, use of a CRT, for the Prepare Function would require training time as the 2F119 is designed. There is no "background" mode.

Brief Function. The 2F119 does not support this function.

FP-2. Few data are available to support the briefing function. There are no displays available in the briefing area.

FP-3. Data available or storable in the 2F119 could be utilized to enhance briefing of student and staff. This is especially true for those integrated missions which are sequential operational problems. Use of critique replay or even demonstrations could aid briefing. Currently, however, this would require trainer time.

Initialize Function. The initialize function includes a) configuring the simulator (cockpits, subsystems and consoles),

b) initializing the simulation program, and c) establishing
readiness for training. Most of the training events begin at
preflight and require that the students complete all cockpit
checks. However, a specific configuration for any other flight
phase can only be verified manually by identifying the required
configuration and then detecting discrepancies by viewing the
appropriate Pilot's Instrument Monitor, Pilot's Console Monitor,
ECMO 1 Console Monitor and Front and Aft Cockpit Displays and
possibly the circuit breaker pages. Any discrepancies must then
be coordinated with the crew in the cockpit(s).

Initializing the trainer requires either a) selecting and
using one of 10 stored ICs, b) selecting and modifying one of
the 10 ICs or c) creating a new IC. In addition to the 36 IC
parameters which can be changed by keyboard entry, a wide
variety of parameters can be changed using input codes with
keyboard entry. Any of 10 parameters can also be frozen at
the Function Display. Over 500 malfunctions can be pre-programmed
to occur.

FP-4. The initializing variations possible in the flight
mode alone far exceed the syllabus requirement. In addition
the time required to exploit the potential exceeds both the
available instructor time and acceptable trainer preparation
time. Unfortunately the implications and interactions of para-
meter settings are left to instructor knowledge and skill.
Flight malfunction characteristics and implications are only
clearly defined in 105 pages of the 588 page Instructor Handbook.
As a result, instructors tend to use the given ICs with little
modification. Programmed malfunctions are rarely initialized.
Input codes (105) and keyboard entry are seldom if every used
by "line instructors." The radio facility set is rarely checked
or modified. The visual system must be independently initialized
requiring both switch input and keyboard entry for up to 26 para-
meters. In summary, the available initializing set of parameters
exceeds requirements; the readily available and useable set is
not well organized or mechanized.

Train Function. The Train Function includes all simulator
operation and instructing tasks (except for performance evaluation)
required to implement the syllabus event including use of demon-
strations, replay, freeze, reset, malfunction insert/removal,
manual simulations (e.g., voice communications), performance
monitoring and data recording.

FP- 5. Simulation of relevant controllers and background
communications is manual and, especially in the integrated
missions, consumes considerable instructor time. Notes must be
maintained of communication flow, call signs, etc. Two instruc-
tors, for example, are required almost full time to simulate the
strike launch from a carrier which is part of integrated missions.

FP-6. Malfunction insertion/removal is typically done by
light pen in real time (programmable techniques are not used).

The time required to access and insert specific malfunctions within the 14 display pages necessitates selecting the malfunctions and utilizing the common display area for a malfunction "standby list". Desired malfunction insertion time is often still difficult to ensure specially in time sensitive flight phases such as take off. Tactics system malfunctions can only be inserted or removed using the Malfunction Display pages (7 pages) or from the Aft Cockpit Display Page (Impending Malfunctions). These are also the only two sources of active malfunction data.

FP-7. Performance monitoring is difficult because of "display competitions". Both the Flight Instructor and the Tactic Instructor have 2 CRTs available for their use. As reviewed in the Introduction, the Flight Instructor has 29 categories of displays (with 167 pages) available and the Tactics Instructor has 14 (with 99 pages). The display options can be classified into 5 types:

1) Index pages - lists of pages/conditions available

2) Data pages - display of detailed data on options/ conditions

3) Monitor pages - display of cockpit panels

4) Control pages - data required for event control

5) System maintenance tests, checks

The first 4 categories are used in most training events. Table 3 categorizes the flight and tactic display options by these categories.

TABLE 3. DISPLAY OPTIONS BY CATEGORY

Category	Flight	Pages	Tactic	Pages
Index Pages	Display Index	1	Initial Operation	
	IC Index	1	(Mission Index)	1
	Procedures Index	2		
	Malfunctions Index	1		
	CEM Index	1		
	Demo Index	1		
Data Pages	Initial conditions	10	Malfunctions	7
			Action Emitter List	1
	Malfunctions	13	Emitter Edit	64
	Input Codes	2	Detailed Effect.	17
	Function	10	General Effect.	1

41

TABLE 3. DISPLAY OPTIONS BY CATEGORY (CONT.)

Category	Flight	Pages	Tactic	Pages
	Visual Status	1		
	CEM Alphanumerics	1		
	CEM Summary			
	Demos	10		
Monitor Pages	Pilot Instrument		Ownship	
	Pilot Console		Strike Group	
	ECMO 1 Monitor		Maneuverable Platform	
	Procedures Monitor		Bar Graph	
	Cross Country		Formal Cockpit	
	Terminal Area		DDI - 1	
	CEM Graphics		DDI - 2	
	Parameter Recording		Aft Cockpit	
Control Pages	Hostile Environment		Emitter Edit	
	ACLS			
	GCA/CCA			

While there is some overlap in display functions, e.g., monitor and control, competition among displays is extensive. Although many of the displays are mission phase specific, many are not. At the flight console, the pilot instrument monitor (or portions of it) are needed nearly fulltime as is one of the map displays. At the Tactics Console, one CRT must almost be dedicated to DDI displays, the other to a map display. The end result is that the instructors are unable both to monitor and control with the existing CRTs. As pointed out earlier, the mission controller seated at the ECMO 1 station with 1 CRT in either flight or tactics does not have the display capability needed.

FP-8. Data recording effectively is unsupported. Although hard copy and "flagged" replay (critique) are available, the difficulty in getting hard copy and the lack of facilities for off line replay preclude the use of these submodes. No other data recording is available other than written notes and instructor memory.

Evaluate Function. The evaluate function includes establishing performance relative to criteria, diagnosing problems, and modifying the event as required. It typically includes the use of freeze, reset and reinitialization.

FP-9. Performance evaluation techniques built into the system are not used. The parameter record submode does not summarize or reduce data nor is it available in a timely manner. The CEM, which is the alternative, is not used as discussed earlier. Other useful modes/displays for example, ACLS, GCA, procedures monitor, cross country and terminal area displays at the flight station and ownship, strike group, maneuverable platform and general effectiveness display at the tactics console provide little quantitative data to aid the instructor. No criteria are stored in the system.

FP-10. No reset function as such is available. Either the trainer must be reinitialized or dynamic replay used. The latter is faster and as a result, dynamic replay is used not as a replay feature, but as a reset feature. Cockpit configuration is a problem and as discussed earlier, no "mismatch" data are generated by the system. Modified resets are not available without either changing initial conditions if reset by ICs or functions (parameter changes) if dynamic replay is used. Both are time consuming and instructor "intense".

FP-11. Reinitializing causes the mission clock to stop and return to zero. Unless restarted, no clock and hence no dynamic replay or critique replay will be available.

Debrief Function. Debrief includes reviewing the event with both the students and the simulator console staff.

FP-12. Although critique replay could support this function the lack of debrief displays and the required system background mode precludes such use. The instructor console displays are not an acceptable debriefing area and trainer time cannot be lost by replays.

FP-13. The system provides no support for simulator staff debrief. Student debrief occurs directly after the event and occupies instructor time. Critique mode could be utilized but time is not available. Notes on student's performance for debriefing take precedence over staff data. As a result, only limited discussion of problems and solutions to training event implementation regarding the integrated mission takes place.

Manage Data Function. The data function includes updating and maintaining training records, and system records. It is unsupported in the 2F119.

Develop Syllabus Function. This function provides for creating and "permanently" modifying simulator software in support of training events. It ranges from modifying initial condition sets and displays to generating programmed missions and scenarios. The PLAN/DFG mode supports this function in the 2F119.

FP-14. The PLAN/DFG mode is a three phase evolution utilizing trainer time and requires both instructor simulator sophistication and computer operator support. Changes are implemented using punched cards. Special format sheets and knowledge of special commands and field locations are essential. The procedure is beyond the capability of all but the most dedicated and experienced instructor. At least a year's experience is probably required for utilizing PLAN. The mode must be utilized to modify or update display pages, develop CEMs, modify malfunction/default values, IC sets, radio facility sets, demonstrations, gaming area, flight paths, vehicle dynamics, missions, and emitter features.

Train Instructor Function. This function provides for instructor training in system operation and utilization. It also includes built-in operating guides or "HELP" functions.

FP-15.   The 2F119 does not support instructor training either in terms of the Instructor Under Trainer (IUT) syllabus or in terms of software aids.

FP-16.   The 2F119 documentation for instructor use is poor. The handbook is designed neither as a training manual nor as a user's manual.

Self/Peer Training Function. This function provides for both training of students in use of the simulator in the "self-train" mode as well as "help" software for the student using the trainer.

FP-17.   The 2F119 does not support this function.

SECTION IV

DISCUSSION

GENERAL

Training Device 2F119 exploited digital technology to develop a simulator with extensive capabilities. Literally any parameter of interest in the EA-6B system and its operational environment can be controlled. The available 265 display pages illustrate the depth of monitor and control possible. That only 5 CRTs at three instructor stations are available to support this capability illustrates the display/control problem facing the instructor(s). The many operability problems, the training functional shortcomings, and the inadequate documentation, coupled with relatively frequent instructor turnover or rotation severely affect on trainer effectiveness. While improvements can be implemented in many areas, the interactive nature of the problems dictates that consideration be given to the overall system as enhancements are planned and implemented. Thus, while display improvements are essential, they must reflect training functional improvements required (such as debrief), as well as any manning and layout changes.

The problems and alternative solutions will be discussed in terms of function, manning and console design. Potential syllabus changes and impacts will also be discussed.

FUNCTION CHANGES

Device 2F119 was not designed to support certain training functions, viz. Prepare, Instructor Train, Data Management and Self/Peer Train. The support to other functions is marginal or unusable because of design complexity and subsystem organization. Thus, for example, CRITIQUE, CEM, and PRINT are not used. The burden placed on the instructors in terms of training time, console manning requirements and training effectiveness is significant. The deficiencies in training function support are major in the sense that changes to the basic software architecture are required in addition to hardware changes.

PREPARE FUNCTION. While support to this function by the simulator is not critical, it can unburden the instructor and enhance training by facilitating planning and organizing of training events. Access to a CRT and stored syllabus data including ICs, malfunctions, scenarios, maps and emitter/target files, for example is needed. Access should not interfere with training or briefing functions. Ideally the terminal should provide the means for the editing required to develop the training event to the point of initialization. At the minimum, it should permit review of all relevant data available in the system.

BRIEF FUNCTION. A briefing subsystem including displays and required controls located in the briefing/debriefing room is needed. At the minimum, the subsystem should include at least 2 CRTs with

controls to initialize, and select displays.   Review of per-
formance objectives, ICs and scenarios, weather, etc. should be
supported.   The facility should also support instructor team
briefing for complex mission scenarios.

INITIALIZE FUNCTION.   Initializing by syllabus event including
random variations of variables should be available in addition
to manual creation of ICs.   If IC preparation is not available in
the PREPARE mode, editing of relevant variables is required.
Editing shall be in user terminology and from a user oriented
data entry unit preferably a cursor and key pad, or touch panel.
Event scenario descriptions should be available.   IC and cockpit
control mismatches must be identified.   Creation of ready lists
of callable conditions such as malfunctions and target-emitter
activity, shall be possible.   Criteria for automatic implementa-
tion should be selectable.   An instructor initialization check
list for the training event should be provided including flags
for any scenario - IC mismatches.   Criteria for any automatic
freezes, crashes or kills must be reviewable.

TRAIN FUNCTION.   The train function includes controlling the simu-
lator, monitoring performance, instructing and recording data.
Operating problems in the 2F119 result in little support to this
function.   Data and event recording features are essentially un-
useable because of access problems.   Performance data collection
is not effective.   Displays are inadequate for performance moni-
toring. Of critical importance is that the console and software
are oriented to simulator parameter control rather than to training
function control.   To support the training function, at least the
following modification should be implemented.

- automated training event scenario evolution with "non-
  destructive" instructor interaction

- single-positive control of manually initiated effects such
  as malfunction insert/removal, emitter activation/de-
  activation/mode change

- student discrete and continuous performance summary output
  (monitor and copy)

- selectable (flags, time, edit) reset with mismatches
  identified

- simulation of routine mission related communications with
  manual override and synchronization controls such as pause
  skip, fast forward/reverse and reset.

- automatic freeze performance options

- procedure error/incomplete alarms

- script/instructor guide monitor

- automated feedback data generation

Reset/replay flag insert in addition to the mission time option is
required.   "Reset" and "Freeze Flyout" should produce any cockpit/

IC mismatches to be displayed.

Procedure monitoring initiated by malfunction insertion and by flight phase designation should be provided. Sequence of completion should be indicated only where required. Completion of check list items should show on active malfunctions lists. A simple access to procedures lists should be available.

Malfunction options should be limited to 30-40 with meaning to the aircrew. Other failures should be available through the programming mode if required. Cockpit indications and actions required should be viewable at the console, either on a display or in an instructor "gouge."

Hardcopy of selected displays shall be available in the console area and output during training so as to be available at the conclusion of the event.

Performance recording should be designed so that selected phases can be summarized and parameters monitored and changed on line. Multiple event timing should be available.

Key monitor display for each phase of the mission should be available continuously, i.e., separate displays should be provided for text material and simulation control/readout.

Since the TRAIN function is the primary key to effective training, implementation to support the function must reflect all system's components including instructors (skill and strategy), syllabus, simulation mechanization and objectives. It must be developed to support training functions, not simulation functions.

PERFORMANCE EVALUATION FUNCTION. In general, the performance evaluation function is not supported by the 2F119 even though various data readouts such as Flight Parameter Record and Performance Monitor and Tactics General Effectiveness, Detailed Jammer & Detailed Communications Jammer Effectiveness and Scoring and Evaluation Bargraph displays are provided. In general, the data are not in formats useable by the instructor nor do the data monitored provide the summarization he requires.

Performance evaluation is primarily an instructor function (except for the simplest rote tasks) supported by data available at the console. The system can support the evaluation both in terms of presenting objective summaries of events and in manipulating and reducing data. Instructor edited, criteria based performance summaries should be provided. Qualification performance criteria should be available for evaluation, diagnosis, and remediation design. Training models should be incorporated to assist the instructor. An interactive performance evaluation model should prove optimum to exploit objective data, training history and instructor inputs.

DEBRIEF STUDENT FUNCTION. Although "CRITIQUE" modes are available for

debriefing in the 2F119, they are not used because trainer time is required and no suitable displays are available. Replay (CRITIQUE) of the previous session simultaneous with training is required. At least 2 CRTs and a CRITIQUE control panel are required in the briefing room. As discussed under the Brief Function, the control must provide for initializing the modes, start/stop, freeze, reset to time or flags and variable speed forward and reverse play. Voice recording synchronized to replay (at normal speed replay) is required. Selection of any display available during the event is optimum. Hard copy of replay displays should be available. For simple tasks or where demos are available, student activated replay (study) should be available. Student "lock-outs" and access codes would be required.

DATA MANAGEMENT FUNCTION. Routine data requirements and reports should be directly available at the console. This includes events completed, students/instructor grade sheets, and utilization time. Output of forms is essential to encourage data input. The primary goal of data management support is to unburden the instructor. The opposite cannot be allowed to occur in implementing support to this function. Interfaces with any functioning training management system should be implemented to enhance this function.

The system should also track mode, module, IC, malfunction, etc., utilization to provide data for software modification.

DEVELOP SYLLABUS FUNCTION. Although a PLAN mode exists and is utilized, the complexity and time required (and available) for its use is prohibitive. Only the most dedicated instructors have mastered and utilized the mode. Punched card operation is inefficient. Interactive training software development in "user language" is essential. Programming aids and built-in tutorials are required. Training software modification/creation shall be designed essentially "fail safe". Permissable changes (without requiring a system programmer) must be well defined and incorporated in the mode. Recall of software usage data is needed. A special input panel is required for the mode. Ideally, the mode should be operable simultaneously with other modes, i.e., development should be able to occur at a separate CRT while training is being conducted.

INSTRUCTOR TRAINING FUNCTION. A "Console Operation" tutorial software package should be incorporated. Certification of qualification by mode of operation should be included and files of instructor qualifications maintained or transferred to other training data management systems. Requalifications and standardization checks can be included. The training package should be integrated with the IUT syllabus and other media utilized in simulator instructor training.

MANNING PROBLEMS

The major problems in manning the instructor console reflect the skill levels implicit in the console design. Although basic familiarization or orientation training events, for example, are simple to implement and can be conducted by "novice" instructors, such is not the case for more advanced training events and especially for integrated mission events. Here training effectiveness is highly contingent on instructor operating skill and knowledge in addition to instructing skills. It appears that about 6 months of training and experience are required to achieve basic console operating proficiency. However, console design and simulator mechanization preclude even the most experienced instructor teams from achieving optimum training effectiveness. Lesser skills degrade training effectiveness directly, especially crew or team training.

As pointed out under Results, simulator operator skill levels vary significantly from apprentice to very highly skilled and knowledgeable. However, medium skill levels are most common since console operation is the first phase of the TD training on reporting to the FASOTRAGRUPAC Detachment.

When console qualified, he is normally assigned to maintenance. While skilled maintenance personnel are on call, they cannot support the instructor in console operations in a timely fashion.

Thus, console operation and training effectiveness in general, vary widely. Training "breakdowns" or "crashes" do occur where low levels of skill exist in both instructors and operators.

The problem is critical where fleet squadron instructors attempt to utilize the trainer. Unless the instructor has recent 2F119 experience from VAQ-129, he will be dependent on the operator for training event implementation. This exceeds the training level and required skills of the operator. Since the operators do not have a station during the integrated mission, the fleet squadron instructors, even if the time were available (4 men for 4-6 hours plus 4 crew) would be unable to conduct an integrated mission effectively.

Thus in summary, manning the consoles of the existing 2F119 on the average will necessarily consist of the following in terms of console operating skills:

a) A marginally experienced operator (TD) (apprentice to experienced) with no operating position in the integrated mode.

b) Marginally skilled instructors (from novice to skilled) for VAQ-129 evolutions

c) Unskilled instructors for fleet squadron training events

It is clear that marginal operating skill levels when coupled with the serious design deficiencies must result in training problems and low effectiveness.

Enhancements to the console can be made to improve operability but manning problems will remain since instructor personnel are required not only to evaluate performance but to impart the current operational environment and tactics to the events, especially the mission training events. Over-mechanization of the console or automation of instruction can degrade this training requirement and result in reduced training effectiveness. In short, advanced tactical training will be dependent on experienced operational instructors. The console and its operation must be modified to exploit these skills within the constraints of instructor tours of duty and squadron readiness training periods.

Demands on "line" instructors are and will continue to be excessive. Requiring FRS instructors, much less fleet squadron instructors, to acquire skills in operating a complex console is clearly unacceptable. The instructor interface must be user and training function oriented. Therefore, the many console design problems must be resolved. Unfortunately, effective use of the wide capabilities of the trainer cannot be achieved by a "start-run-stop" console, especially in mission training. Thus, a skilled operator(s) will be essential to support Instructor personnel. The console design must be a function of the number and skill levels to be provided.

Assuming console operation will be accomplished or supported by skilled operators, additional manning requirements are then contingent upon problem control and "student" evaluation requirements. Experience has shown that flight and tactics and any other part-task modes which evolve, can be accomplished by one instructor with minimum training in simulator operations. In fact, elementary position training may be accomplished by the operator if the syllabus event and criteria are well programmed in the trainer.

Integrated or mission training may present a similar picture, i.e., if the trainer event/scenario is well prepared and software support optimized. Instructor requirements could be reduced to two, (front cockpit and rear cockpit) and conceivably one, since cockpit activity peaks independently (e.g., front cockpit during take off, enroute navigation and landing and back cockpit during the mid-portion EW). However, this would require an instructor fully proficient at all crew positions which is not the norm.

Although the 2F119 instructor staff requirements could be reduced with the use of highly qualified simulator operators, the skill levels required exceed those observed on the 2F119. Two other alternatives exist to implement a reduction in manning assuming an appropriate design of the console. One alternative is to recruit and hire civilian simulator "instructor-operators"

preferably with EW and EA-6 experience, and train them in 2F119 operation. Under this approach, line instructor personnel will be primarily training "managers" and evaluators with full implementation of the event at the console being performed by specially qualified civilian instructor-operators. Unique console stations and controls and displays would be required for this approach. It could provide the best solution to fleet squadron use since minimum manpower and special training is required of them. In addition, the personnel could provide the expertise required to develop and modify software modules to meet instructional requirements. "Continuation" training of the special civilian instructor-operators would be required, especially in system changes, procedures changes and above all, in EW including EOBs, emitters, etc. Complete job responsibilities thus becomes important. The requirement for currency in the EW area and the system would appear to indicate collateral duties with the Electronic Warfare Department of VAQ 129 in addition to primary simulator instructor duties. Sufficient personnel would be required to support both fleet and VAQ-129 training, especially mission training. Current 2F119 requirements are estimated at 14 hours utilization, 12 for VAQ-129 and 2 for fleet squadrons. This is projected to increase to 4 hours for fleet use. Civilian instructor operator requirements can be estimated from these data and syllabus events.

The readiness syllabus includes 7 integrated missions and 2 flight mode events. In hours, the 20 flight mode events require about 43 hours (plus briefing/debriefing time) and the integrated about 21 hours (plus briefing/debriefing time). Fleet requirements are about 9 hours integrated and 8 hours flight mode (plus brief/debriefing time). Thus of the total 81 hours simulator time required for the syllabus events, approximately 30 or about 37% involve integrated missions. If utilization is projected at 14 to 16 hours a day, about 5 hours on the average will be integrated missions. With briefing time, at least 10-15 hours a day integrated time are required. If one instructor-operator is required for these events, two simulator instructor-operators could probably handle the workload. In summary, utilizing specially qualified instructor operators to support mission training, instructor requirements could be reduced to one flight and one ECMO instructor with minimum simulator operating skill required. The operational instructors would be concerned primarily with crew evaluation and scenario modification required by crew performance and any special training requirements. The instructor-operator would be responsible for implementing the scenario and modifying it as required. The simulator operator would be required to support the instructor-operator and to keep the system operating.

The second alternative is to train the operators in system operation in response to operational instructor requirements. Some training of instructors in 2F119 operation and performance would be required. Three instructors might still be required, two for crew evaluation and one for scenario development control. However, instructor skills in simulator

operation could be significantly reduced. Modification to the console would include two operator stations, two instructor stations and one mission controller. The approach places additional instructor training and manning requirements on fleet squadrons for 2F119 use.

SIMULATOR SYLLABUS

As discussed earlier, the 2F119 readiness syllabus includes 20 flight mode events (11 pilot and nine ECMO) and seven mission events (two pilot and five ECMO). No tactics modes are scheduled. Of the flight mode events, four are procedures training; one is an acrobatics-spin hop; two are radar/NAV training; two are NATOPs evaluations. The pilots also get two NCLTs. Thus, the flight mode is utilized as a CPT for eight events, a part-task trainer (Radar/Nav) for four events, a NCLT for two events and an OFT for four events (NATOPs and spin). The full trainer capability is being little used for these events. Unique console requirements exist for some of the events, especially on platform "show and tell," NCLTs, radar operation training and spin training. Operator support requirements also vary.

Should integrated mission training requirements increase, additional trainer time could be made available by providing for multi-mode part task training within the 2F119 capabilities or by procuring part-task trainers. For example, at least the first of the Radar/Nav events, if not both, could be conducted utilizing the radar unit (APQ-129) and the computer panel (AYA-6) and the DRLMS in a Radar/Nav submode compatible with simultaneous procedures events, e.g., spin training, NCLT training or NATOPS training. The first two of the procedures events could be supported in a simplified front seat mock-up with a stand alone micro computer or in a submode of the 2F119.

Simultaneous operation of the tactics and flight modes (not integrated) could provide tactics training if the 15E22 fails. In addition, as further modifications and improvements to the system occur, the 2F119 may be required to support one version of the OBS tactics training. Simultaneous independent flight and tactics training would require that no motion simulation be utilized.

In summary, console modifications should consider various alternative modes of training and syllabus events.

DOCUMENTATION

The instructor handbooks for the Device, NAVTRADEV P-4534 (2 volumes), create a major user problem. The handbooks, as delivered, meet no single requirement and, in effect, are unuseable by any specific user. The flight instructor handbook is over 600 pages in length. It satisfies none of the requirements for:

a) Engineering Development Rational Data

b) Training Manual

c) Operators Guide

d) Console Reference

Yet, it is the only documentation provided to meet their needs. For example, the 123 page appendix is the only source of information on what the over 500 malfunctions available actually involve in terms of cockpit indications in the aircraft, in the trainer and on the console as corrective action is taken. Almost 100 pages are devoted to the PLAN mode. Yet, it is descriptive in content and does not review the procedures required.

The primary users of the manuals are the instructors, all of whom are familiar with and utilize the NATOPs manuals. This format could be employed for the operator's handbooks and for the console guide. The former should resemble the "-1" NATOPs manual; the latter should resemble the PCL or "-B" NATOPs document. A manual capitalizing on this well used and accepted format should be effective.

At least three separate documents should be provided by the developer. These include: a) a System Description, b) an Instructor Training Manual and, c) an Operation Handbook.

The System Description Document is the basic instructor reference manual. It should include data such as system layout and subsystem and interface detailed functional descriptions. User oriented function flow charts should be included.

The Instructor's Training Manual should provide the course outline and lesson guides for the instructors training program for operation of the device. The manual should provide means for update and modification.

The Operation Manual should be designed as an easy reference guide for console use by qualified instructors. It should be designed for easy quick reference while operating the simulator.

PROCUREMENT PROBLEMS

Although the analysis of procurement procedures was not part of the survey, it is clear that most of the problems found could have been prevented during the design and development stages and detected during test and evaluation. That they were not, is not a reflection on the FPT but rather on a process which fails to provide critical technical assistance to such a group or to require data review by relevant technical experts. Any modification should not be undertaken with the same approach.

DESIGN PROBLEMS

A wide variety of design deficiencies could be seen in retrospect. Many of them are basic human factors engineering problems which should have been solved during design and development. Others relate to functional design features and user implementation. As pointed out earlier, most of the design problems, while individually minor, are cumulative and interactive and have impacts far beyond the particular deficiency. The problems identified in the results section will be discussed under the following topics:

- layout
- lighting
- display
- control
- operation

Many of the problems overlap these categories as will be obvious in the following sections.

LAYOUT PROBLEMS. In retrospect, the functional layout of the 2F119 created several problems. Stray light on consoles and traffic in the instructor area are caused primarily by the spacial layout with the only access to the mockup through the instructor area. Short of reconstructing the balcony and ramps, the only feasible solution is to reorient the console. Figure 12 illustrates an alternative which isolates the console from traffic flow. Relocation of the interlock indicator lights may be required to make them visible. Screens should be added if light spillage from the bay area or hall or briefing room doors occurs. More acute "wrap" angles could be utilized but must reflect any display change implemented.

The indicators and controls on the panels are not well arranged. A consistent organization both in terms of function and operating sequence should have been employed. In addition a visual distinction between indicators and switches is needed. Unused indicators and switches should be removed or covered. Similarly labeled controls should perform the same function. Except for blanking out unused indicators or switches, changes to the panel arrangement is not warranted unless the panel is to be redesigned. Then close adherence to functional grouping followed by sequence arrangement should be maintained.

Each instructor station should have display and control locations optimized for use. The visual scene display at the instructor console for example should be angled more to the instructor seat position for better viewing. (The display is angled acutely from the seated eye positions.) If displays are to be shared, the tactics and flight stations should be more severely angled to the ECMO 1 station. If display changes
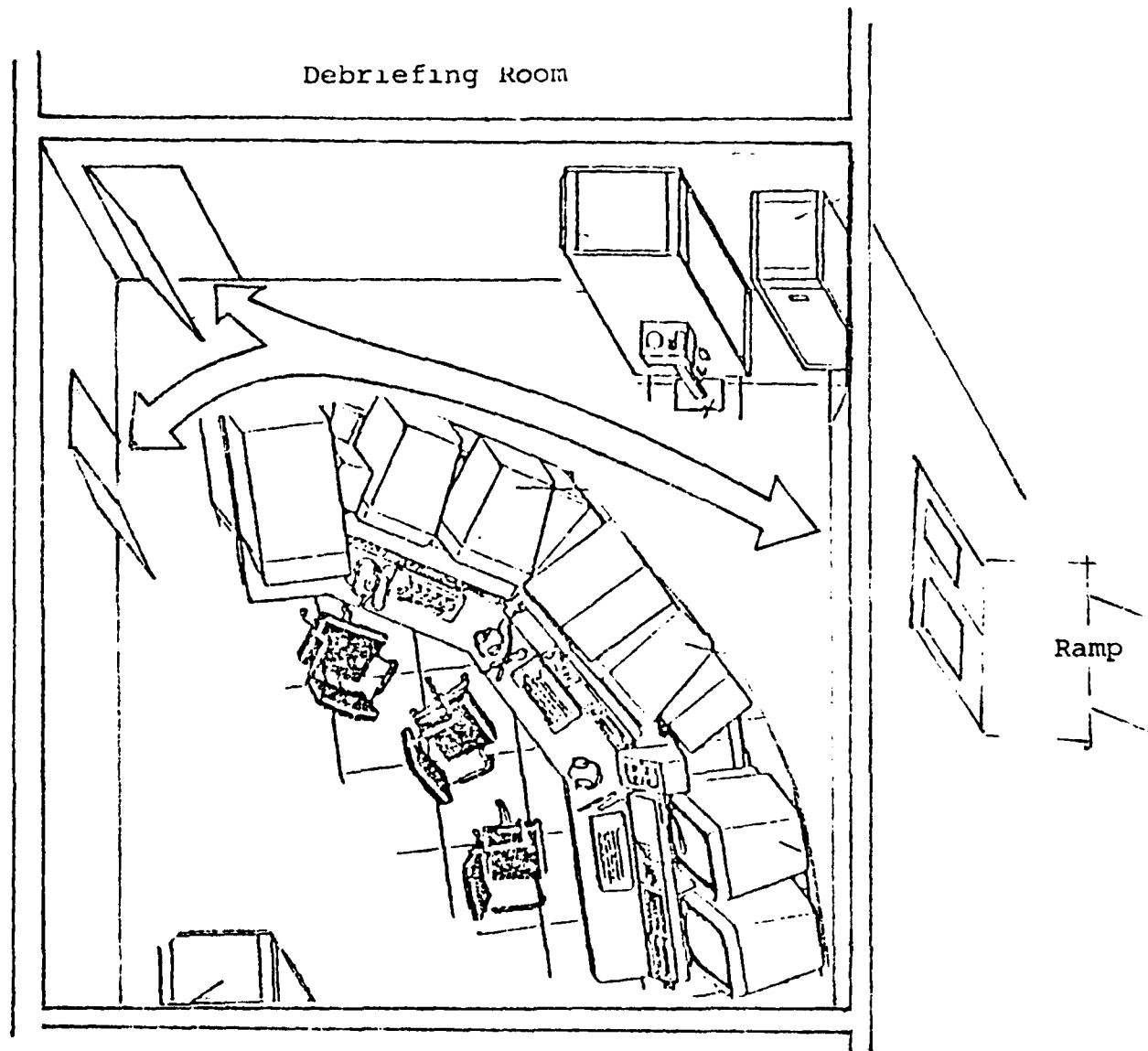
Figure 12. Feasible Console Arrangement

are made, the relative instructor station angles should reflect any display sharing requirement (and speech communication requirement) while optimizing each station display arrangement relative to a fixed seat reference point.

Displays must be positioned (viewing distance and angle) so that they are readable (character size, contrast, etc. must be taken into account). If light pens are retained, the entire CRT display plate must be moved within reach (less than 24 inches from shoulder reference point) and angled to minimize parallax (at right angles to line of regard).

Document storage bins at each station are essential. The single storage "slot" for FKB overlays is inadequate and leads to excessive wear of the overlays. Storage should be provided for frequently used documents including NATOPS PCL, call sign cards, scenarios, and operating "gouges." Writing space must be maintained at the console.

Careful attention must be paid to the location and arrangement of displays and controls added to the debriefing area. Up to 7 or 8 persons may be viewing the displays simultaneously.

LIGHTING PROBLEMS.

Console lighting must be adequate to read control and display legends from the normal instructor operating position. While integral lighting is optimum, flood lighting is acceptable. Lighting of the visual system control panel is essential. Use of the lights "test" feature to illuminate legends is unacceptable.

Distinguishing indicators from switches is important. In addition, color coding of indicators should be implemented. Indicators should be coded red for emergency, amber for caution, and green or blue for advisory data.

Console area lighting should be rheostat controlled <u>from the</u> console. Since three stations are involved, a central location should be utilized, such as the ECMO 1 station.

DISPLAY PROBLEMS

A wide variety of display problems exist. Most can and should be corrected. A wide variety of options are available. However, no change should be initiated without analyzing the impact and interactions on the consoles as a whole. The following display changes should be implemented.

1) Monitor Displays

a) Flight monitor displays are required which provide the instructor basic flight, engine and subsystem data. These displays should not be time shared.

b) DDI monitor displays are required for both ECMO positions. The displays should not be time shared. Readout of primary control settings should also be provided and not time shared. DDI display options independent of ECMO selection is desirable.

c) An integrated mission instructor station with two CRTs and related controls is essential. The CRTs should be able to call up required displays either flight or tactics without changing modes of operation.

d) An LSO display option should be provided at the flight CRTs for NCLT.

e) The GCA display should be modified to expand the last two miles. The message model should be improved. Approach plate data such as MDA and DH should be added.

f) The ACLS display should be oriented North up and a heading strobe added to the aircraft symbol. Approach plate data should be added.

g) Approach plate data should be added to the terminal area map.

h) Some means of correlating the hostile and tactical environments must be implemented. Coordination at the mission control instructor station would be optimum.

i) An aircraft heading strobe should be added to the tactical map display to aid in jamming evaluation.

j) Textual material on the CRTs should be extensively edited and reduced in quantity, especially malfunctions, procedures, emitter edit, and similar pages.

k) Meaningful performance data displays should be added/substituted for existing performance displays to aid in instructor performance evaluation.

CONTROL PROBLEMS

A wide variety of control design problems exist which degrade simulator performance and create instructor training problems. The problems should be corrected and the related display changes made which interact significantly. Unfortunately the control problems are not minor improvements and will require both hardware and software changes.

a) Light pens are unsatisfactory as simulator control devices, at least in the training modes. They should be replaced by a simpler more positive technique such as a cursor with a ball or joy-stick control or a touch panel. In either case, relocation of the

displays should accompany the change to enhance read-
ability. Analyses of control dynamics and cursor
shape to optimize display point acquisition without
"hunting" or masking data should be completed before
implementing a cursor design. Interaction with
functional controls and modes will require resolution.

b) The alpha numeric keyboards should be removed as
primary instructor input/control devices and only
retained if necessary for maintenance functions and
programming. They should not remain on the console
during training operations. A single numeric key
pad (or if necessary, alpha numeric pad) should be
provided in connection with improved software to
permit required editing. Data input should be in
user/operational terms, i.e., no codes or pro-
gramming instructions/language should be utilized.

c) CRT selection or designation controls should be
specific to the display. The existing CRT selec-
tor (thumbwheel) is neither a positive control of
CRT display nor is it a read out of the display
selected. Some displays automatically appear under
software control such as initial displays, terminal
area, "zero" set, and transferred displays. A
simplified display control/read out with single
action mechanization should be incorporated. Im-
provements to the functional keyboard will interact
with the display control changes and must be
resolved.

d) Communications controls should be simplified. Pos-
itive single action control of the three types of
communication (i.e., student, radio and inter-
instructor) is essential. Since communications are
momentary in nature, controls should be "press-to-
talk." Microphone switches could be used to select
the function - student, radio or instructors.
Secondary switches should be used for further desig-
nation as required with a simple "override" to in-
clude all channels available (such as all students,
all radios, or all instructors). The solution to
the inter-instructor/operator communication require-
ment will interact and must be resolved. Multi switch
communications panel should not be employed. The use
of head set and boom type microphone (with clip-on
or hand-held "switch pad") should be optional at both
the console and adjacent to the cockpit for "on-
platform" instructing.

e) Switch default conditions should be re-analyzed and
set accordingly. Among the changes required should
be the following default conditions:

- Mission clock "ON" when initialized (Relabel)
- Crash override "ON"
- Auto-approach Inhibit "ON" (Relabel)

Changes to the FKB and communication panels may require other default conditions.

OPERATION PROBLEMS

Major operating problems must be corrected if the effectiveness of the 2F119 is to improve. Basic operating software changes are involved. When implemented, the impact on displays and controls and other change requirements must be resolved.

1) Simultaneous mode operation. The capability of simultaneous operation or utilization of modes and submodes is essential, not only to achieve efficient trainer utilization but also to provide required support to simulator training. Ideally, only two primary modes of trainer operation should be available, namely operate and maintain. Under the operate mode, any of the following submodes should be available to support training without interfering with on-going training.

   a) Debrief (replay in the debriefing area)

   b) Print (hard copy of designated displays)

   c) Brief (display of event scenarios, ICs, maps, etc.)

   d) Prepare (display/edit of event ICs, missions, maps, etc.)

   e) PLAN/Program (user software development not including "test" or "debug")

   In addition, simultaneous sub-system training should be possible, namely tactics only and flight-only. In addition, other part-task options, if incorporated, such as Radar/NAV, should be available unless required by flight or tactics events.

2) Map centering by cursor control rather than latitude-longitude input should be incorporated.

3) LIST inputs should either be automatic as part of initial conditions for "canned" missions or by cassette (for example) for student planned missions. Requiring manual loading once the technique has been learned expends simulator training time.

4) Hostile environment/tactical environment correlation techniques are required to effectively utilize weapons effects simulation.

While locatable weapons are desirable, at least trans-
lation and rotation of the hostile environment "grid"
over the tactical area should be provided to achieve
maximum correlation of emitters, forces and weapons.
Automatic editing or inhibiting of weapons as a func-
tion of emitter activity and jamming effects should
be incorporated. Uncorrelated weapons (e.g., no enemy
platforms) should be deleted from the display. Program-
mable weapons launches would be optimum.

5) Emitter control should be simplified. Control from
displayed information including ON-OFF and mode (if
applicable) should be available without accessing
additional display pages. Activation of emitter "sets"
should be programmable during initializing. Deactivation
or override of programmed emitter activity should also
be available.

6) Performance measurement algorithms should be "callable"
by the instructor. The detailed models applicable to the
EA-6B mission must be developed. The format should
permit extensive instructor interaction including evalu-
ation inputs and overrides. Routine performance measures
such as time, errors, and continuous variable summarization
should be "on-call." Mission evaluation models to permit
crew or squadron "shoot-offs" are desirable since air-
borne operations are restricted and costly.

7) Instructor software aids should be available. "HELP"
modules integrated with the operating software to guide
the instructor through complex mechanizations should be
incorporated. Error messages should not be utilized as
such unless corrective action or solution is provided as
an option.

SECTION V
CONCLUSIONS

GENERAL

The 2F119 instructor console, while providing almost un-
limited access to and control of simulation parameters is not
designed for efficient and effective training operations.
Significant functional and display/control design deficiencies
exist. The end result is unacceptable instructor staffing
requirements, unacceptable instructor training requirements,
loss of training time and poor utilization of trainer capa-
bilities. The problems literally preclude fleet squadron
use of the trainer for other than NATOPS/OFT type events.
The "lessons learned" should be transferred to future speci-
fication and procurement to avoid similar problems.

Modifications to enhance the effectiveness of the 2F119
are urgently needed if fleet squadrons are to be supported
and readiness training made efficient and effective. While
a wide variety of fixes of the design problems found could
be implemented, a "piece meal band-aid" solution is not
available nor should it be attempted except for immediate
temporary relief. Human engineering fixes will not solve
the major operating problems even though the existing inter-
face would be improved. For example, relocating and re-
orienting the displays to enhance light pen use will not
solve the problem that the light pen is not a satisfactory
control device for most console requirements.

SPECIFIC CONCLUSIONS

The following conclusions were reached:

1) Operability problems in the 2F119 console compromise
simulator efficiency and effectiveness and render the device
almost unusable by fleet squadron personnel as a mission
trainer.

2) Manning requirements and resultant training problems
impact severely on effectiveness and utilization.

3) Modifications to the instructor console and the soft-
ware can be made which will significantly contribute to
EA-6B crew training both at the FRS and at fleet squadrons.

4) Modifications to the instructor console should only
be undertaken following a training requirements and simu-
lator operations analysis by experienced human factors
personnel.

5) The following three types of documents are required
for console users. The NATOPS format should prove useful for
the last two.

a) Instructor Operator Training manuals

b) Instructor System Manual

c) Instructor Console Guide

6) Provisions for simultaneous modes of operation are required. These include:

a) replay for briefing/debriefing in designated spaces

b) print or hardcopy output in console area

c) interactive training software modification/development

d) training event review and edit

e) part-task training modes

7) Performance measurement and data reduction are required. Parameter monitoring techniques and data "dumps" are not useable by the instructor. Performance measurement is distinguished from performance evaluation which, in general, must be performed by the instructor.

8) Simulator operator skill requirements and tasks must be defined and implemented. Console stations to implement these functions must be provided. A skilled operator will be required to support the instructor staff if instructor console operation training requirements are to be reduced to an acceptable level. An operator station at or near the console is required.

9) Specialized "instructor-operators" will be required for fleet squadron use of the trainer especially in the mission or integrated mode. The instructor-operator should be capable of implementing the training event to the scenario required by the operational instructors. The fleet instructor role becomes one of evaluating crew performance, and indicating modifications (on-line and off-line) to the scenario. Console operating functions could be reduced to the use of flags for replay and print, freeze, replay, reset, etc. With proper station display/control design, a briefing at the console before training could suffice for fleet instructor console operation training.

10) Realistic cockpit monitoring displays are required for the operational instructors use in observing and evaluating crew performance. The displays should not be time shared with data or simulation control displays.

11) Mission training for the EA-6B system with its four man crew involves a highly complex scenario and environment. A scenario or problem controller-instructor is essential if the event is to be "orchestrated" to meet training objectives. An instructor station to support this function must be implemented. At a minimum, two CRTs with access to all relevant displays, both flight and tactics are needed.

12) A replay (CRITIQUE) capability for debriefing is required. The capability must be available on-line, i.e., simultaneous with training. Displays and replay controls should be located in the debriefing room. The display locations should accommodate up to eight viewers. The controls should provide complete control of the replay including freeze, skip to flags, events, etc. Hardcopy should be selectable. Audio replay should be available. Ideally multi track recording should be utilized to permit editing of instructor comments, background radio, etc. Three channels to match console selection would be optimum, i.e., student ICS audio, radio audio and instructor audio.

13) Displays for the LSO are required if NCLT is to be conducted. They should include a head-up type of display and a plot of key parameters, such as RPM or fuel flow, pitch, angle of attack, sink rate, and similar parameters selectable by the LSO.

14) Consideration should be given to either procuring part-task trainers or adding additional submodes to the 2F119 if mission training requirements expand. Since the device is a full-mission trainer, use as a part-task trainer especially as an orientation or basic position trainer, is not efficient unless positions training can be conducted simultaneously utilizing most of the device's capability. This could be accomplished, for example by training options such as front cockpit normal and emergency procedures, rear cockpit OBS training, and radar, CCI and communication jamming equipment operation training at the ECMO 1 console simultaneously. (Motion could not be utilized.) While scheduling would be more complex, trainer utilization would be significantly increased and additional mission time might be created. The operating system would be required to support at least three separate "trainers", namely, a) a front cockpit trainer in a procedures training mode without the DRLMS or the motion system, b) a rear cockpit trainer and c) a radar/NAV trainer using the DRLMS. Console design changes would be required.

15) Instructor console documentation is inadequate.

16) The programming mode (PLAN) is inefficient and too complex for instructor use.

17) A wide variety of simulator features are not utilized. Some are not required (e.g., DEMO) and some are unuseable because of design (e.g., PRINT, CRITIQUE, RECORD, CEM, Performance/ effectiveness measurement).

18) The instructor area arrangement is poor in terms of traffic and lighting.

19) The instructor console displays and controls are not optimum. They create operating problems and unacceptable instructor/operator training requirements. Display options especially of data, exceed requirements and usability. Display formats need enhancements such as heading strobes, and environment correlation.

SECTION VI

RECOMMENDATIONS

GENERAL

As discussed the optimum solution to achieving effective
trainer utilization requires a systems engineering approach to
identify and evaluate alternative changes. The interaction of
the system components, especially instructors, operators, console
design and simulator training function-support precludes
achieving an all encompassing, component-based fix. The consoles
as mechanized are deficient for any feasible mix of instructors/
operators. Utilization of the trainer is constrained by the
software operating system which does not permit multi-mode
simultaneous operations. Fleet and Readiness squadron manning
constraints preclude solutions involving additional manpower
or especially trained and dedicated instructors.

Therefore, the primary recommendation is made that:

Recommendation 1. Change Analysis.
        A limited analysis of Device 2F119 operational constraints
and requirements be conducted along with a trade study of alter-
native change configurations to permit the definition and specifi-
cation of useable, acceptable, effective and efficient changes to
the Device and its implementation.

SPECIFIC CONSOLE RECOMMENDATIONS

With the caveat outlined above, the following detailed reco-
mmendations to solve specific isolated problems are presented.
The recommendations being specific, do not consider all of the
interactions involved. They are presented in rough order of
importance and priority.

Recommendation 2. Instructor-Operators.
        At least two professional instructor operators should be
hired to support mission training. The instructors should be
EA-6B experienced if possible. The billets should probably be
functionally located at VAQ-129 with primary duty as a 2F119
integrated mode instructor-operator and collateral duty at
the EW department to maintain currency in EW and systems. The
duties in addition to 2F119 instructor-operator should include
mission programming (utilizing the PLAN mode) to implement new
training scenarios. Training and qualification of the personnel
should be accomplished by VAQ-129 and standardization by
MATVAQWINGPAC. The recommendation assumes that required console
changes will be incorporated to support the instructor-operator
function.

Recommendation 3. Device Operating System.
        The software operating system should be changed to permit
simultaneous operation of the following training modes and
submodes. (Only maintenance and program test or "debug" should

require a dedicated system.)

       a)   Flight Mode

       b)   Tactics Mode

       c)   Print Submode

       d)   Replay Submode

       e)   Instructor event review/edit

       f)   Radar/NAV orientation training (DRLMS available)

The recommendation assumes that additional required displays and controls are available for briefing/debriefing and instructor editing.

    Recommendation 4. Monitor Displays.
        Dedicated monitor displays are required at the flight and tactics instructor stations. At least one display (repeater or full graphics CRT) is required at the flight station for primary, flight, power and configuration data and two displays at the tactics console for DDI 1 and 2. Instructor optional selection of DDI display mode is desirable.

    Recommendation 5. Light Pen and ANKB.
        The CRT light pens and the alphanumeric keyboards should be removed as primary instructor control devices. Simpler, positive, single action devices must be substituted. Feasible alternatives include cursor with joy-stick or ball, touch panel, numeric key pads and "touch-tone" key pads.

    Recommendation 6. Mission Control Displays.
        Two CRT displays are required for the mission/problem instructor or instructor-operator, one primarily for tactical maps and one for problem control. Display options should include all map displays, target/emitter control displays, hostile effects control displays and initial condition/mission/parameter control displays. Depending on other station enhancements, reallocations of displays may be possible.

    Recommendation 7. Operator Requirements.
        A trained operator should be provided for each instructor in the flight-only and tactics-only modes of training. Minimum qualifications for operation should be established. The objective is to minimize instructor console operation training. Therefore, the operator must be capable of implementing all conditions involved in these modes of training as required by the instructor.

    Recommendation 8. Operator Station.
        An operator's station should be implemented to permit the operator to operate the trainer as required in flight, tactics and mission training. An existing console station may not be available if simultaneous modes of training are

incorporated (Recommendation 3) and is not available in the
mission (integrated) mode.

Recommendation 9. Brief/Debrief Console.
Displays and controls to provide training event replay
for briefing and especially debriefing should be implemented.
At least two full-graphics CRTs will be required with controls
to select displays and control replay. Replay control should
provide for mission time or instructor flag reset with variable
forward/reverse speed and freeze. Hard copy should be avail-
able. Audio-replay should be available. Viewing conditions
should accommodate up to eight personnel. Rheostat room light-
ing control will be required at the console.

Recommendation 10. LSO Displays.
If NCLT is to be conducted, displays for LSO use are
required. A modified head-up display will be required in
addition to approach data readout.

Recommendation 11. Instructor Console Layout.
The instructor console should be arranged to clear a
"traffic lane" to the mockup boarding ramp. The rearrangement
should preclude student view of instructor stations and prevent
stray light from striking the displays or console personnel.

Recommendation 12. Performance Measurement.
Performance measurement models should be developed and
incorporated to facilitate crew member, crew, and unit readiness
evaluation. Instructor interaction for evaluation is essential.
Performance measures shall be summary in nature to minimize in-
structor processing requirements. Routine measures such as
elapsed time should be readily available.

Recommendation 13. Simulation Options Reduction.
A major reduction in simulation options available at
the console should be made. Malfunctions should be reduced to
no more than 30 or 40 (the other 460 may be accessible in the
PLAN mode). Procedures for monitoring should be equally reduced
except that all "boldface" procedures and normal procedures
checks should be retained.

Recommendation 14. Display and Control Changes.
The human engineering design deficiencies and feasible
solutions discussed should be implemented. The many human en-
gineering and display/control deficiencies should be corrected.

PROCUREMENT RECOMMENDATIONS

Although procurement procedures were not analyzed as such
during the study, the following recommendations reflect de-
ficiencies exposed.

Recommendation 15.   Documentation

New specifications for documentation relevant to the instructor console are required. At least three types of documents are required. These are:

    a)   Instructor/Operator Training Manuals

    b)   Instructor System Manual

    c)   Instructor Procedures Manual

The latter two manuals should utilize the NATOPS format - the System Manual resembling the "-1" manual and the procedures manual, the PCL or "-B" manual. The procedures manual should be stowable at each instructor station.

Recommendation 16.   Procurement Procedure Requirements

An analysis of the console procurement procedure should be undertaken to identify shortcomings and loopholes, especially in the human factors area. It is clear the procedures do not include adequate human factors effort. Some of the agencies and organizations may not have the staff required to monitor such efforts. The FPTs, for example, with broad responsibilities in the specification of requirements and the evaluation of the im-plementation of requirements and the evaluation of the implemen-tation have little if any access to human factors expertise. The analysis should include an in-depth look at how human factor requirements can be addressed and monitored at all levels.

Recommendation 17.   Base Line Specifications

State-of-the art specifications should be developed to establish a base-line for the instructor and system operating consoles and stations. None currently exist which provide a starting point for the design or tailoring of the console to meet requirements. Thus the Device 2F119 console was in effect a Research and Development effort in which the FPT was forced to make decisions on displays, controls,and arrangements.

Recommendation 18.   Design Guide Data

Generalizable design guide data based on the problems identified in Device 2F119 are contained in Appendix C. This information should be utilized in future trainer procurements to preclude the reoccurence of these problems.

BIBLIOGRAPHY

1. Charles, John P., Willard, Gene, and Healey, George. "Instructor Pilot's Role in Simulation Training", NAVTRAEQUIPCEN 75-C-0093-1, Naval Training Equipment Center, Orlando, FL, March 1976.

2. Charles, John P. "Instructor Pilot's Role in Simulation Training (Phase II)", NAVTRAEQUIPCEN 76-C-0034-1, Naval Training Equipment Center, Orlando, FL 32803, August 1977.

3. "NATOPS Flight Manual Navy Model EA-6B Aircraft", NAVAIR 01-85ADC-1, Naval Air Systems Command, Washington, D.C., June 1977.

4. "Instructor Hardbook EA-6B Weapons System Trainer Device 2F119", NAVTRAEQUIPCEN P-4534, Naval Training Equipment Center, Orlando, FL, 15 December 1980.

5. "Instructor's Manual", TACELRON 129, NAS Whidbey Island, WA, March 1981.

APPENDIX A

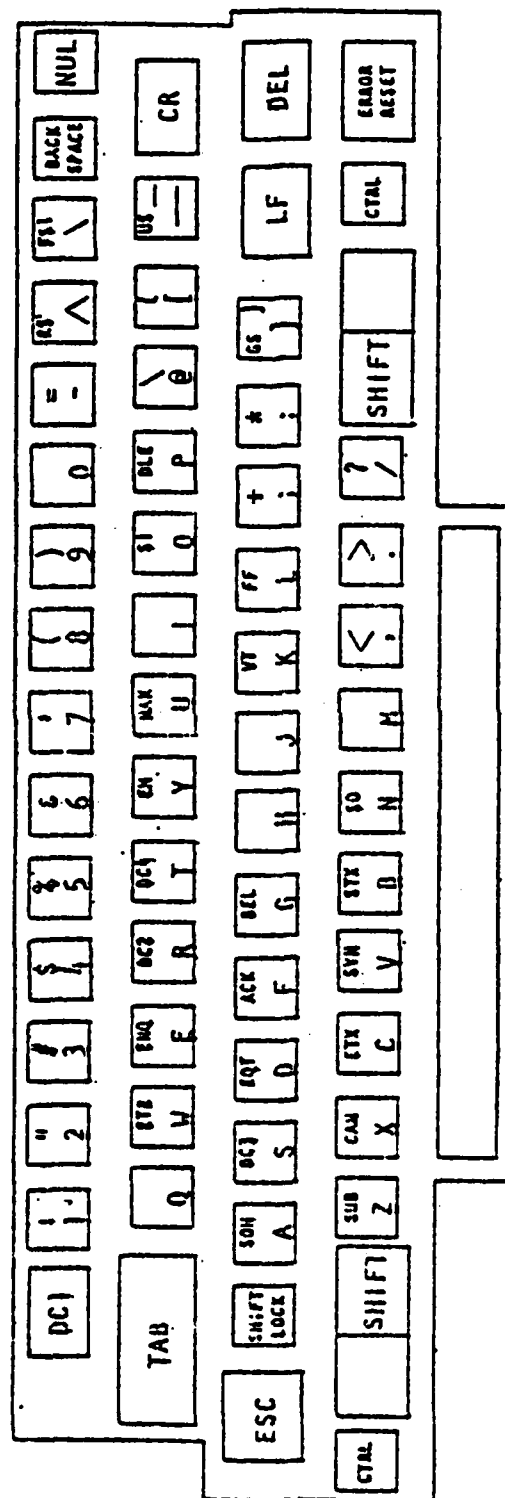Device 2F119
Selected Console Panels

Figure A-1. Flight Instructor Alphanumeric Keyboard
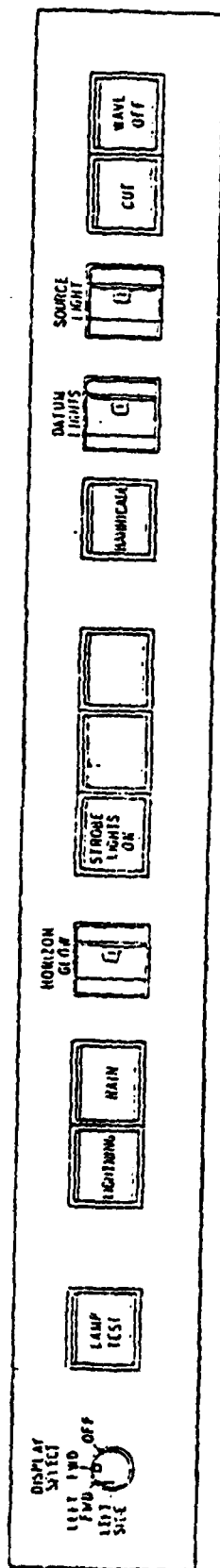
Figure A-2. Visual System Control Panel

INIT COND | PILOT INSTR | PILOT CONSOLE | ECHO-1 MONITOR | PROC INDEX | PROC MONITOR | HALF INDEX | HALF OVRD

INPUT CODES | FUNCTION DISPLAY | VISUAL MONITOR | PARAM RECORD | PARAM RECORD FLAG | NAV COMPUTE UPDATE | CLEAR PRINT STORAGE | CRT STORE

CROSS COUNTRY | TERM AREA | ACLS | GCA/CCA | 600X600 40X40 | 300X300 36X36 | 150X150 24X24 | 75X75 12X12

DELETE UNTUNED FACS | MAP SLEW | ACFT SLEW | AUTO APP INHIBIT | CEM DISPLAY | MAN ADV | MAN RET | CEM SUMMARY

FLIGHT OPERATE

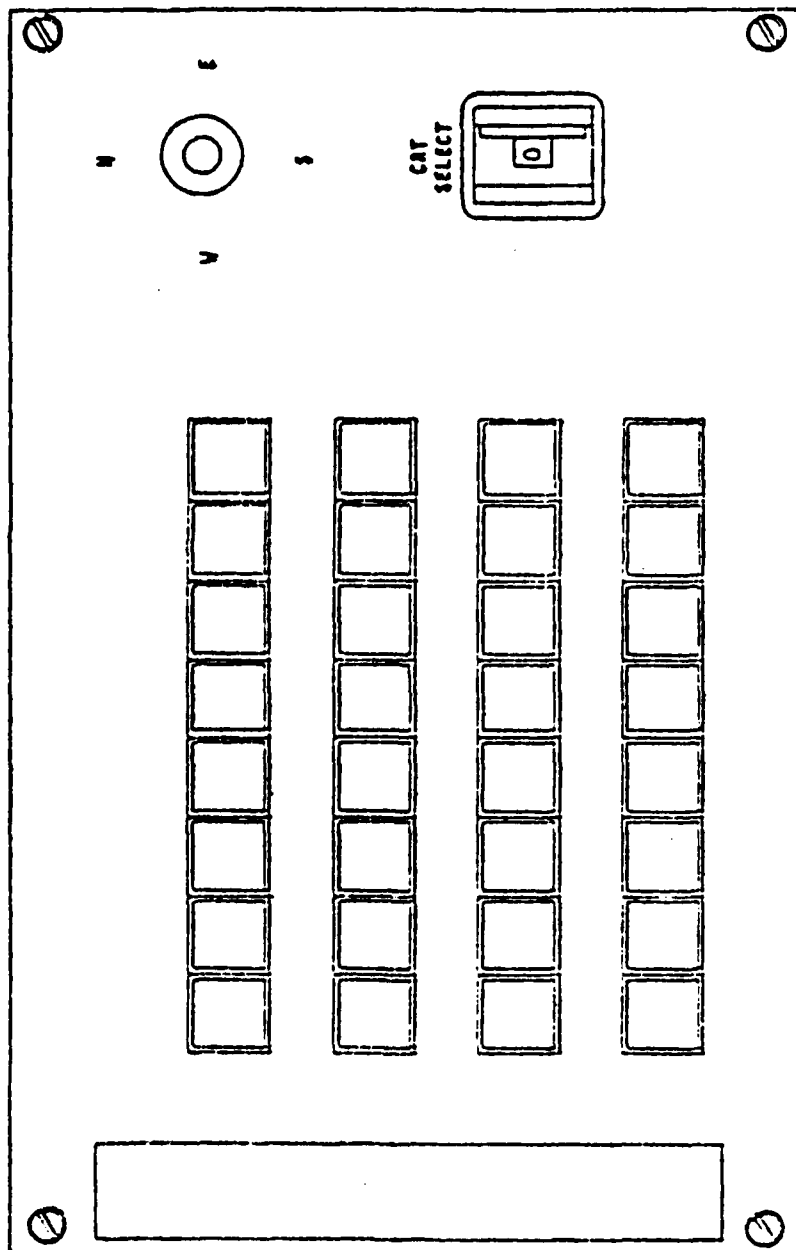Figure A-3. Sample Overlay for Function Keyboard (See Figure A-4)
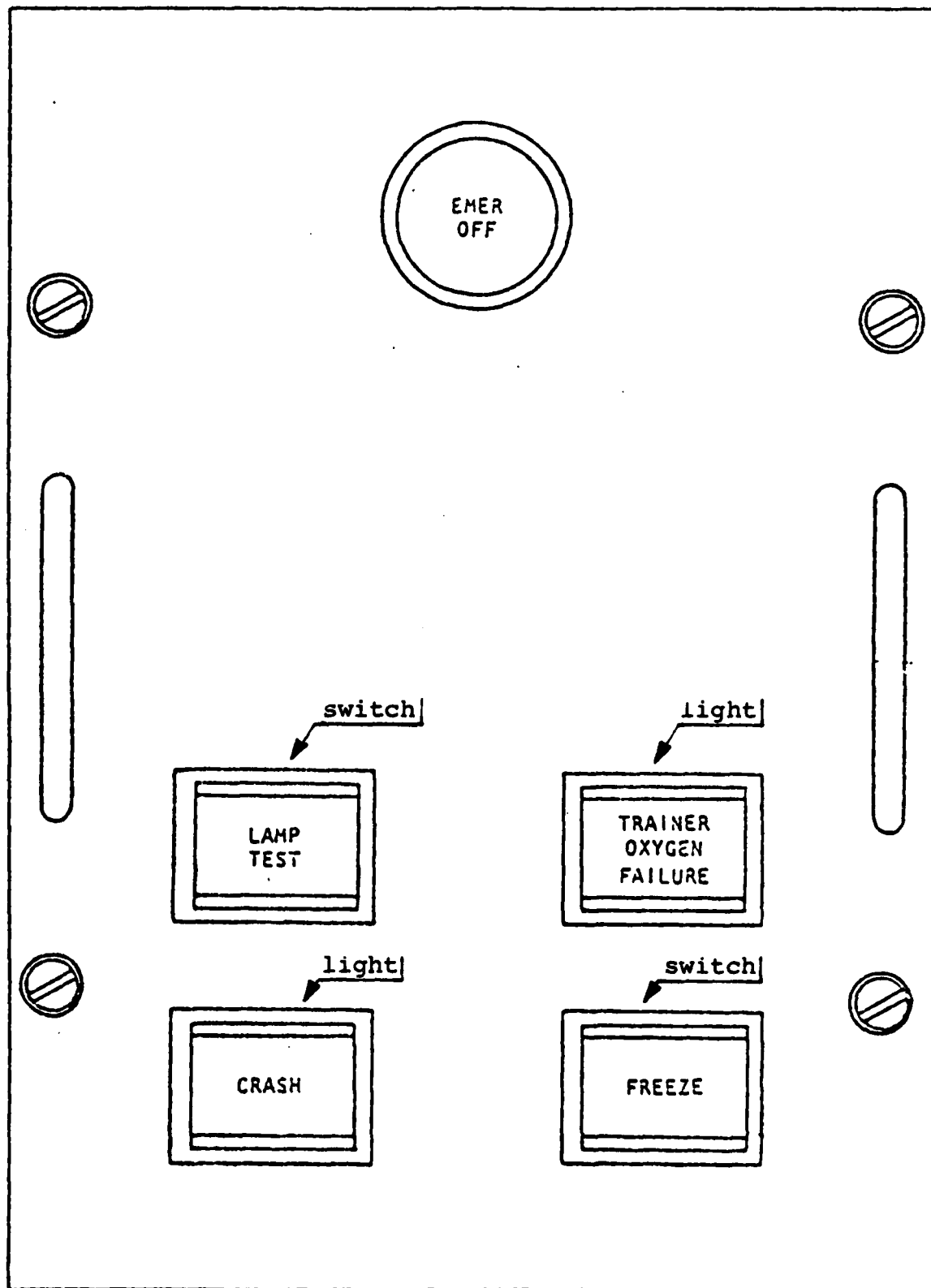
Figure A-4.   Function Keyboard

Figure A-5.   ECMO-1 Trainer Control Panel
(Showing similarity of lights
and switches.)

APPENDIX B

Simulator Training Functions (1)

---

(1) From, Charles, John P., "Instructor Pilot's
    Role in Simulation Training (Phase II) NAVTRA-
    EQUIPCEN /6-C-0034-1, Naval Training Equipment
    Center, Orlando, FL, August 1977.

I PREPARE FUNCTION

1.1 Identify Session

- student
- time
- simulator
- syllabus hop
- simulator status

1.2 Assemble Materials

- student file
- syllabus hop description
- scripts
- scenarios
- check lists/guides
- initalization data
- data recording sheets
- grade sheets
- simulator utilization sheets
- flight plans, etc.

1.3 Review Data

- student history - performance problems/weakness
                  - missing training elements
- syllabus hop - objectives
              - performance criteria
              - priorities
              - implementation procedures
- simulator status

1.4 Develop Training Session

- individualize syllabus to students' needs
- modify initial conditions as required
- schedule and program malfunctions/emergencies
- structure controller functions
- develop tactical scenarios
- format demonstrations
- structure performance measurement
- structure display and control
- contingency plans
              - performance failures
                  - crash
                  - missed procedures
                  - unacceptable accuracy/quality
          - simulator reset strategy
          - simulator emergency
                  - fire
                  - hydraulic malfunctions

- loss of communications
- area safety
- outline briefing sessions
  - student(s) - objectives
    - criteria
    - procedures/approach
    - simulator problems
  - simulator staff - responsibilities
    - evolution strategy

II BRIEF FUNCTION

2.1 Brief Student(s)

- planned evolution
- learning objectives
- performance criteria
- simulator emergency procedures
- simulator discrepancies and characteristics
- planned use of training controls - Freeze, Reset, Replay, Demonstration, etc.
- communication procedures
- flight plan data

2.2 Brief Simulator Crew

- planned evolution
- support responsibilities
- emergency procedures

III INITIALIZE FUNCTION

3.1 Configure Simulator

- configure simulation system
- configure crew station
- configure IP console

3.2 Initialize Simulator

- enter or verify initial conditions
  - airfield and runway locations, altitudes and arrangement
  - carrier types, positions, speeds, headings, sea state
  - radio/navigation aids locations and characteristics
  - target locations, characteristics and behavior
  - environment - ceilings, visibilities,

> > temperatures, winds, magnetic
> > variation
> > - aircraft configuration
> > - aircraft position and heading (if
> >   airborne, altitude, heading, speed,
> >   attitude and power)
> > - malfunctions/failures
> > - preprogrammed malfunctions/emergencies
> > - data monitor/record settings
>
> - enter preprogrammed data
> - initialize crew station

3.3 Establish Readiness

- student(s) strapped in cockpit
- area secure and safe
- scripts, scenarios, data sheet, etc., available
- make communications check with student and crew

IV TRAIN FUNCTION

4.1 Control Simulator

- activate simulation
- provide interacting man-system simulations per
  scripts/guides/scenarios
  - controller functions
  - ground crew functions
  - other aircrew functions
  - other vehicles and targets, air,
    ground, sea, submarine, missiles
  - Radar and early warning system
- activate/deactivate emergencies/malfunctions
- select and activate demonstrations
- set and select replay
- freeze
- initialize and reset
- monitor safety of operations
- deactivate trainer at end of session

4.2 Monitor Performance

- procedures
- technique
- skill level
- simulator performance

4.3 Instruct

- provide feedback

- critique
- correct procedures
- provide technique advice

4.4 Record

- data for feedback
- data for simulator control, i.e., reset, replay
- data for debrief
- data for records

V EVALUATE FUNCTION

5.1 Monitor relevant parameter for segment/phase/task
5.2 Establish if performance within training performance
    envelope
5.3 If performance beyond envelope, diagnose problem
5.4 Select instruction technique to train
5.5 Develop plan and data to implement technique
5.6 Brief simulator crew and student as required

VI DEBRIEF FUNCTION

6.1 Debrief Student

- organize data collected
- assemble debriefing materials
- review performance problems (replay if available)
- review correct procedures, etc. (demo if available)
- review file data
- outline corrective actions to take

6.2 Debrief Simulator Crew

- review problems
- review overall performance
- discuss simulator discrepancies

VII MANAGE DATA FUNCTION

7.1 Student Data

- student grade sheets, training sheets
- simulator training data sheets

7.2 Simulation System Data

- utilization data
- discrepancy data

7.3 Training Data

- problems
- changes tried/proposed
- instruction techniques

VIII DEVELOP SYLLABUS FUNCTION

8.1 Identify Changes
8.2 Format Changes
8.3 Implement Changes
8.4 Validate Changes

IX TRAIN IP FUNCTION

9.1 Simulator Operation

- console familiarization
- console operation
- operating procedures
- syllabus implementation

9.2 Simulator Training

- training functions
- training techniques
- evaluation
- simulator instructing

9.3 Simulator Syllabus Development
9.4 Standardization Training

X SELF/PEER TRAIN FUNCTION

10.1 Basic Simulator IP Function
10.2 Syllabus Lockouts

- preclude "getting ahead of instructor"
- preclude student data file access or change

10.3 Performance Lockouts

- stop training if performance bad or not improving
- stop training if skill overlearned

APPENDIX C

Training Device Design Guide Data

APPENDIX C

TRAINING DEVICE DESIGN GUIDE DATA

GENERAL

Design problems and feasible solutions identified in the study of the instructor console of Device 2F119 which are generalizable to other devices were summarized. They are presented under the headings of:

- Console Layout
- Panel Layout
- Lighting
- Controls
- Displays
- Miscellaneous
- Functional Requirements

CONSOLE LAYOUT GUIDES

1. Instructor Consoles areas shall be isolated from normal student and instructor traffic flow to and from briefing rooms, personnel equipment racks and access to the student station/ mockup.

2. Instructor station layout shall comply with human factor's engineering design criteria especially in terms of control/display locations relative to instructor eye and seat reference points.

PANEL LAYOUT GUIDE

1. Detailed control panel design criteria shall be con- sistent throughout the console.

2. Legend terminology shall comply with Naval Training Equipment Center Standard (to be developed).

LIGHTING GUIDES

1. Instructor area lighting shall be controlled from the console. Lights shall be dimmable.

2. Integral control panel lighting is preferred. Flood lighting is acceptable. Lighting shall meet human factors criteria.

3. Indicator lights shall be color coded red for emergency/ hazard, amber for caution, and green, blue or white for advisory

data. The coding criteria applies to console functions, not weapon system conditions.

4. Indicators unless color coded shall be distinctively different in appearance from controls.

5. Lighting of legends shall be adequate to read the legend from the normal seated position of the instructor.

6. A console table light (flood) for writing shall be provided if the table ambient lighting is normally less than 10 footcandles.

CONTROLS

1. Light pens and similar devices shall not be used for control of functions which are time sensitive or in situations requiring dedicated perceptual-motor activity.

2. Alpha numeric computer-type keyboards should not be utilized at instructor stations except for maintenance and programming functions.

3. Display/control dynamics shall be set to minimize "target" acquisition time. Cursors shall be displacement or line-space controlled.

4. Instructor microphone controls shall be press-to-talk. Switches should be located on the microphone or if a boom type, on a portable switch pad. Separate switches for student, radio and inter-instructor communication should be provided, preferably on the microphone. An emergency override (all circuits) is required.

5. Positive single-action control of malfunctions and "target" activation/deactivation is required. Sets of malfunctions/targets shall be similarly controllable.

6. Activation of preplanned conditions such as malfunctions, target activity and environmental change should not require loss of scenario control or monitoring displays. Access to the condition index and/or descriptive data pages should not be required for activation/deactivation.

7. Basic simulator controls shall be centrally located and perceptually coded if possible. The controls shall include "FREEZE", "EMERGENCY STOP", "MOTION ON" AND "MOTION OFF". The "FREEZE" control shall be push to set, and push to release or equivalent. "FREEZE" shall blink or equivalent to indicate a transition period for the function.

8. Training controls should include "RESET" and "REPLAY". Selection shall result in automatic FREEZE. At least the

following reset options shall be selectable, a) reset to initial conditions, b) reset to a flag, or c) reset to a selected mission time. REPLAY shall be setable to a) the maximum available, b) a flag, c) a specified mission time, or d) to a "searched" point.

9.   Slew controls for cursors, targets or aircraft shall be display oriented, i.e., up-down, left-right.

DISPLAYS

1.   Console monitors of trainee station controls and displays should be conformal in perceptual relevant content and shall not be time shared with simulation data/control displays.

2.   Map displays shall be North "up" unless otherwise selected or required by the mission scenario.

3.   "Inside-out" displays shall be platform heading "up" unless otherwise selected.

4.   Console display selection readout shall be positive, i.e., the display selector and display must agree.

5.   Display and the use of elapsed time shall be in the same format.

6.   Editing options for cluttered displays are required. The editing options shall be scenario relevant and user selectable.

7.   If CRTs are utilized, a "common area" preferably at the bottom of the display shall be used for data and control of variable conditions such as malfunctions, weather and targets. On monitor displays, the common area will include data on:

- last 10 control inputs ("push down")
- active malfunctions/targets
- procedure being monitored (incomplete)
- stacks of setable conditions

MISCELLANEOUS

1.   Document storage space shall be provided at each instructor station and shall be adequate for operating guides, syllabus guides, system check lists, and any special data lists.

2.   Speaker and microphone locations shall minimize the possibility of feedback.

FUNCTIONAL REQUIREMENT

1. Simultaneous operation of the following functions is required.
   a) training - with all simulation capabilities including RESET and REPLAY
   b) debrief - with data from the previous training event
   c) brief - with data on the next scheduled event

In addition, the following are desirable:

   d) event preparation - with data edit of ICs, maps, etc.
   e) mission/event programming

2. Routine weapon system data loading and system initialization shall be optionally available as part of the IC to increase training time.

3. Routine communications relevant to the simulation shall be selectable and controllable by the instructor.

4. Realistic routine background communication shall be available.

5. Performance measurement technique shall be provided. The measurements must be summative and incorporate optional instructor inputs. Performance models are desireable.

GLOSSARY

ACLS	Automatic Carrier Landing System
ALT	Altitude
ANKB	Alpha-Numeric Keyboard
AOA	Angle of Attack
CCA	Carrier Controlled Approach
CDP	Control/Display Problem
CEM	Computer Evaluated Mission
CRT	Cathode Ray Tube
DDI	Digital Display Indicator
DFG	Disc File Generation
DH	Decision Height
DRED	Daily Readiness (tests)
ECMO	Electronic Countermeasures Officer
EOB	Electronic Order of Battle
EW	Electronic Warfare
FASOTRAGRUPAC	Fleet Aviation Specialized Operational Training Group, Pacific Fleet
FKB	Functional Key Board
FRS	Fleet Readiness Squadron
GCA	Ground Controlled Approach
IAS	Indicative Air Speed
IC	Initial Condition
ICAP	Improved Capability
ICS	Intercommunications System
INFO	Instructor Naval Flight Officer
IUT	Instructor Under Training
IOC	Instructor Operating Console
LP	Layout Problem
MDA	Minimum Descent Attitude
NAS	Naval Air Station
NATOPS	Naval Air Training and Operating Procedures Standardization
NCLT	Night Carrier Landing Training
NTEC	Naval Training Equipment Center
OBS	On-Board System
OFT	Operational Flight Trainer
PCL	Pocket Check List
PTT	Part Task Trainer
SO	Simulator Operator
TD	Training Deviceman
TJS	Tactical Jamming System
VSI	Vertical Speed Indicator
WST	Weapon System Trainer
XMTG, XMT	Transmitting

DISTRIBUTION LIST

Naval Training Equipment Center   50
Orlando, FL 32813

Technical Library
Naval Training Equipment Center
Orlando, FL 32813

Commanding Officer
Navy Submarine Base New London
ATTN: Psychology Section, Box 600
Groton, CT 06340

National Aviation Facilities
Experimental Center
Library
Atlantic City, NJ 08405

CDR Joseph Funaro
Code 602
Human Factors Engineering Div.
Naval Air Development Center
Warminster, PA 18974

Commander
Naval Air Development Center
ATTN: Technical Library
Warminster, PA 18974

Technical Library
OUSDR&E
Room 30122
Washington, DC 20301

Director
Defense Research and Engineering
Washington, DC 20301

Commanding Officer
Air Force Office of Scientific
   Research
Technical Library
Washington, DC 20301

OUSDR&E (R&AT) (E&LS)
CAPT Paul R. Chatelier
Room 3D129, The Pentagon
Washington, DC 20301

Dr. Genevieve Haddad
AFOSR/NL
Bolling AFB, DC 20332

Chief, Research Office
Office Deputy Chief of Staff
   for Personnel
Department of Army
Washington, DC 20310

Office of Naval Operations
OP-115D
CDR Jim Lawhon
Washington, DC 20350

Assistant Secretary of the Navy
Research, Engineering & Systems
Washington, DC 20350

Chief of Naval Operations
OP-115
Research, Development & Studies
Room 6836
Washington, DC 20350

Office of Deputy Chief of Naval
   Operations
Manpower, Personnel & Training
   (OP-01)
Washington, DC 20350

Chief of Naval Operations
OP-593B
Washington, DC 20350

Chief of Naval Operations
OP-987H
ATTN: Dr. R. G. Smith
Washington, DC 20350

Chief of Naval Operations
OP-596C
Washington, DC 20350

Chief of Naval Material
MAT 031M
Washington, DC 20360

CDR Dick Gibson
Naval Air Systems Command
Code 413
Washington, DC 20361

Naval Air Systems Command
Code 334A/CDR Tom Jones
Washington, DC 20361

Defense Technical Information Center
Cameron Station
Alexandria, VA 22314   12

LT Thomas N. Crosby
Naval Air Systems Command
Code 5313X
Washington, DC 20361

Commander, Naval Air Systems Command
Technical Library
AIR 950D
Washington, DC 20361

Commander, Naval Sea Systems Command
Code 61R2/Mr. P. J. Andrews
Washington, DC 20362

Director, Personnel & Training
  Analysis Office
Building 200-3
Washington, DC 20374

Naval Research Laboratory
ATTN: Library
Washington, DC 20375

Scientific Advisor
Headquarters, US Marine Corps
Washington, DC 20380

Scientific Technical Information
  Office
NASA
Washington, DC 20546

Federal Aviation Administration
'echnical Library
Bureau Research and Development
Washington, DC 20590

Dr. Jesse Orlansky
Institute for Defense Analyses
Science & Technology Division
1801 N. Beauregard St.
Alexandria, VA 22311

CDR P. M. Curran
Office of Naval Research
800 N. Quincy St.
Arlington, VA 22217

Commander, Naval Air Force, US
  Atlantic Fleet
Mr. Robert Goodwin
Norfolk, VA 23511

Personnel & Training Research Programs
Office of Naval Research
Psychological Sciences Division (Code 458)
800 N. Quincy St.
Arlington, VA 22217

Commanding Officer
Fleet Combat Training Center Atlantic
ATTN: Mr. Hartz, Code 02A
Dam Neck, VA 23461

Commander, Naval Air Force, US Atlantic
  Fleet
ATTN: Robert Goodwin
Norfolk, VA 23511

Commanding Officer
Naval Education Training Program &
  Development Center
ATTN: Technical Library
Pensacola, FL 32509

Mr. Craig McLean
USAF, ASD/YWE
Wright-Patterson AFB, OH 45433

Mr. John Schreibner
Naval Air Systems Command
Code N-4131
Washington, DC 20301

Dr. Kenneth Boff
AFAMRL/HEA
Wright-Patterson AFB, OH 45433

Commanding Officer
Human Resources Laboratory
Operational Training Division
Williams AFB, AZ 85224

Mr. Harold D. Warner
AFHRL/OT (UDRI)
Williams AFB, AZ 85224

Chief of Naval Education & Training
  Liaison Office
Human Resources Laboratory
Flying Training Division
Williams AFB, AZ 85224

Commanding Officer
Naval Education & Training Center,
  Pacific
Code N-5B (Mr. Rothenberg)
San Diego, CA 92132

Dr. Robert C. Williges
Industrial Eng. & Operations Rsch.
Virginia Polytechnic Inst. & State
  University
Blacksburg, VA 24061

David M. Eakin
Bell Aerospace Textron
Naval Coastal Systems Center
Bldg 319
Panama City, FL 32407

Paul W. Caro
Seville Research Corp.
400 Plaza Bldg.
Pensacola, FL 32505

Mr. A. E. Plogstedt, M/S 100
McDonnell Douglas Astronautics Co.
P.O. Box 600
Titusville, FL 32780

R. W. Schultheis, Jr.
Computer Systems Division
Perkin-Elmer
7200 Lake Ellenor Dr.
Orlando, FL 32809

Joseph R. Gleydura
Goodyear Aerospace Corp.
1210 Massillon Rd.
Akron, OH 44315

James R. Bridges
Program Mgr. Tng. Equipment
General Dynamics
Land Systems Division
P.O. Box 1901
Warren, MI 48090

McDonnell Douglas Astronautics Co.
ATTN: E. J. Reilly
Dept E080, Bldg 106, Level 2
P.O. Box 516
St. Louis, MO 63166

Ross E. Ailslieger
Crew Systems Technology - M.S. K36-40
Boeing Military Airplane Co.
3801 S. Oliver St.
Wichita, KS 67210

Jerry Wages
Bell Aerospace Textron
6800 Plaza Drive
New Orleans, LA 70127

Christopher Lin
United Airlines Flight Training Center
Stapleton International Airport
Denver, CO 80207

Vernon E. Carter
Northrop Corp.
Human Factors
3901 W. Broadway
Hawthorne, CA 90250

Edward C. Taylor
TRW Defense Systems Group
#1 TRW Circle
Redondo Beach, CA 90277

Stanley M. Aronberg
Mail Code 35-93
Douglas Aircraft Co.
3855 Lakewood Blvd.
Long Beach, CA 90846

Clarence Semple
Canyon Research Group, Inc.
741 Lakefield Rd., Suite B
Westlake Village, CA 91361

John P. Charles
ICON, Inc.
3401 Bangor Pl.
San Diego, CA 92106

Mr. R. Dupree
Cubic Corporation
Defense Systems Div.
9333 Balboa Ave.
San Diego, CA 92123

Mr. Jeff Punches
Mathetics, Inc.
P.O. Box 26655
San Diego, CA 92126

Mr. L. D. Egan
Logicon, Inc.
P.O. Box 80158
San Diego, CA 92138

Ms. Katie M. Dent
Lockheed Missiles & Space Co.
P.O. Box 504
Organ. 60-95, Bldg 156A
Sunnyvale, CA 94088

Commander, Naval Air Force
US Pacific Fleet
Code 316/Mr. Bolwerk
NAS North Island
San Diego, CA 92135

Commanding Officer
Fleet Training Center
ATTN: Training Department
Naval Station, San Diego, CA 92136

Commanding Officer, Fleet Combat
  Training Center, Pacific
Code 09A
San Diego, CA 92147

Commanding Officer
Fleet Anti-Submarine Warfare
  Training Center, Pacific
Code 001
San Diego, CA 92147

Mr. Frank Fowler
3306 TES (ATC)
STOP 223
Edwards AFB, CA 93523

Commander, Naval Weapons Center
Human Factors Branch (Code 3194)
ATTN: Mr. Ronald A. Erickson
China Lake, CA 93555

Dr. David C. Nagel
LM-239-3
NASA Ames Research Center
Moffett Field, CA 94035

Dr. J. Huddleston
Head of Personnel Psychology
Army Personnel Research
  Establishment
C/O RAE, Farnborough
Hants, ENGLAND

Eclectech Associates
North Stonington Professional Center
P.O. Box 178
North Stonington, CT 06359

Dr. Thomas Hammell
Eclectech Associates
P.O. Box 178
North Stonington, CT 06359

Grumman Aerospace Corp.
Plant 36, C02-04
ATTN: Mr. Sam Campbell
Bethpage, LI, NY 11714

Martin Plawsky
Grumman Aerospace Corp.
C21-05
Bethpage, NY 11714

Glynn R. Ramsay
Gould, Inc.
Simulation Systems Division
Melville, NY 11747

Martin Morganlander
Gould SSD
50 Marcus Drive
Melville, NY 11747

Drs. Cohen and Stark
Link Division
The Singer Company
Binghamton, NY 13902

Bob Gamache
Singer-Link FSD
Colesville Rd.
Binghamton, NY 13902

Robert T. Hennessy
Committee on Human Factors
National Research Council
2101 Constitution Ave., NW
Washington, DC 20418

E. Scott Baudhuin
Singer-Link
11800 Tech. Rd.
Silver Spring, MD 20904

Joseph L. Dickman
Sperry Systems Management-SECOR
12010 Sunrise Valley Dr.
Reston, VA 22091

Raymond G. Fox
Society for Applied Learning Technology
50 Culpeper St.
Warrenton, VA 22186

Mr. John B. Sinacori
P.O. Box 1043
Hollister, CA 95023

Mr. Wolf J. Habensteit
Crew Systems & Simulation Technology
The Boeing Aerospace Co.
P.O. Box 3999, M.S. 82-87
Seattle, WA 98124

Colonel M. D. Calnan (DODC)
National Defense Headquarters
Ottawa, Ontario, Canada K1A 0K2

END

FILMED

2-83

DTIC